SIZE DISTRIBUTION AND ABUNDANCE OF CULTIVABLE PENAEID PRAWNS IN COCHIN BACKWATER DURING SOUTHWEST MONSOON

DISSERTATION SUBMITTED BY

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CERTIFICATE

This is to certify that this Dissertation is a bonafide record of the work carried out by Miss SHEEBA SUSAN MATHEWS under my supervision and that no part thereof has been presented before for any other degree.

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C O N T E N T S

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P R E F A C E

The dynamic environment of the estuaries and adjoining backwaters plays a vital role in the fishery of the coastal areas in general and the prawn fishery in particular. Because of the great demand for prawns in the fish trade circle and in view of the limitations in the exploitation of natural resource, there has been global awakening, in recent years, to find out ways and means for augmenting prawn production through coastal aquaculture. One of the essential inputs required for successful prawn culture is the availability and the timely supply of prawn seed for stocking in the fields. In nature, larvae, postlarvae and juveniles of different species of prawns occur throughout the year in the inshore waters and in the estuaries and backwaters. However, their abundance varies from place to place and with season depending on the spawning intensity, survival of eggs and larvae, spawning season and the ecological variations.

Estuarine environment plays an important role on the survival, abundance and distribution of prawn seed and juveniles. The Cochin backwater system is the largest of its kind in the west coast as well as the most affected ecosystem at present by human interferences. Man-made changes on this environment occurring by the reclamation processes, deforestation, dredging operations, construction of salt water barrage (at Thanneermukkom), release of pollutants in water and overexploitation of nursery grounds have serious impact directly or indirectly on the living resources of the ecosystem.

Very little information is available in literature on the impact of these man-made changes on the environmental characteristics in relation to the living resources of the ecosystem. For a judicious exploitation of the resources, it is necessary to have up-to-date knowledge precisely on the magnitude of the available resources and on the environmental characteristics influencing the ecosystem. But, reliable data on quantitative estimation of seed resource and their availability in space and time, particularly during monsoon season, are lacking except for a few centres. Such information, particularly on cultivable species, is vitally important, not only to initiate large scale intensive culture in coastal areas but also would help in the judicious exploitation of the resource.

This dissertation presents the results of investigations carried out in the Ernakulam channel of Cochin backwater system on the size distribution and abundance of cultivable penaeid prawns during southwest monsoon months, commencing from June to September 1987. The main objectives of the present investigation are to obtain accurate data on the availability, distribution pattern with reference to size, sex and relative abundance of penaeid prawn seed and juveniles, particularly of Penaeus indicus, Metapenaeus dobsoni and Metapenaeus monoceros during southwest monsoon season, in relation to the existing ecological characteristics of the changing environment by the reclamation process going on at present in this channel for city development and to have quantitative estimation of their seed resources available during this particular season.

This comprehensive study was planned since no previous work of such detailed nature has so far been carried out from this water body extending between Thevara in the south and Vaduthala in the north of the Cochin backwater system during southwest monsoon season.

The results and discussion of this Dissertation embody mainly sections relating to aspects on the distribution pattern in relation to size and sex, the relative abundance by number and weight, the Hydrography in relation to prawn abundance and on the quantitative estimation of penaeid prawn resources.

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INTRODUCTION

Prawns constitute one of the most profitable marine living resources. Their very high price and demand in the world market paved way for the development of shrimp fisheries in India. In the initial stages, it was Kerala that brought India in the map of 'Shrimp exporting countries of the world' and at present, Kerala stands second in prawn landings from the west coast.

In India, penaeid prawns contribute nearly 65% of annual trawl catches and the fishery is constituted mainly by Penaeus indicus, P. monodon, P. semisulcatus, Metapenaeu dobsoni, M. monoceros, M. affinis, M. brevicornis and Parapenaeopsis stylifera; while in Kerala it is constituted predominantly by P. indicus, M. dobsoni, M. monoceros, M. affinis and P. stylifera. They breed in the sea and their larval stages, except P. stylifera, involve a temporary estuarine phase in the life-cycle.

The life-history of these penaeid prawns, in general, consists of egg, nauplius, protozoea, mysis, postlarval, juvenile, subadult and adult stages. The nauplii moult six times and transform into protozoea stage which feed on phytoplankton. After two moults, they develop into mysis stage. They feed on zooplankton and moult twice before becoming postlarval stage. The postlarvae migrate towards nearshore coastal waters, estuaries and backwaters. This process is known as "recruitment" or "immigration". The postlarvae attain juvenile stage within a fortnight after undergoing rapid moultings.

When the formation of external sexual organs takes place, the stage is known as 'preadult' or 'subadult'. The duration of development from the postlarval to the subadult stage varies from 5 to 6 months. The preadult goes back to the sea for maturation and spawning, thus completing the life cycle. The seaward migration is known as "emigration". Thus, these penaeid prawns spend part of their life cycle in the estuarine environment. From the fishery point of view, the exploitation of penaeid prawns takes place at the juvenile and preadult stages in the estuarine areas and at the adult stage in the inshore waters of the sea.

During the last decade, no remarkable increase in the annual landing of prawns has been observed in spite of much increase in fishing efforts (CMFRI Annual Reports, 1976-1985). Silas et al, (1981) indicated that overfishing in inshore waters could be one of the causes for their depletion. Owing to their scarcity in nature and increasing price and demand, there has been great awareness, in recent years, to find out ways and means of augmenting production through coastal aquaculture practices.

The estuaries and backwaters of Kerala provide good nursery grounds for several species of prawns and fisheries. 'The Cochin backwater system' is the largest of its kind in the west coast of India, where large scale penaeid prawn culture is carried out traditionally as well as on modern scientific lines. From time immemorial, a rich juvenile shrimp fishery existed in the low saline upper reaches of this estuarine system. But, the commissioning of Thanneermukkom bund, a salt barrage across the Vembanad Lake, in 1975 has affected the tidal influence very much and reduced the extent of backwater nursery grounds by 25% which has led to the collapse of the juvenile shrimp fishery in this region (Gopalan et al. 1983).

In recent years, several ecological changes have again taken place in this ecosystem as a result of man-made interference such as deforestation, dredging operations, reclamation processes, release of pollutants from industries and agriculture and overexploitation of nursery grounds. Heavy accretion and siltation of sand and silt by Pamba and Periyar River discharges, as a result of acute deforestation, have not only reduced the mean depth, thus affecting tidal influence in the upper reaches of southern and northern regions, but also affected adversely the bottom topography and nursery beds of prawns. Failure of monsoons, another after-effect of deforestation, and their seasonal upset experienced in the past few years have considerable adverse effects both directly and indirectly on the prawn fishery resources. The dredging operations and reclamation processes going on, at present, in the Cochin backwaters may have serious impact on the benthic communities, especially the economically viable penaeid prawn seed and juvenile resources of the estuarine ecosystem.

Studies on penaeid prawn seed resources are of paramount importance in the context of capture as well as culture fisheries. Their recruitment pattern will help to assess the success of the prawn fishery in the estuary as well as in the sea and also to indicate the spawning season, which in turn provides pertinent information on the occurrence of spawners to initiate hatchery operations.

Recruitment of postlarvae of penaeid prawns in varying magnitude takes place round the year. Their varying magnitude among species in the estuarine environment is related to spawning intensity and several environmental factors such as rainfall, temperature, salinity and tidal currents. These factors play important role in the fluctuation of prawn fishery resources in the estuarine and marine environment. For a judicious exploitation of this resource, it is essential to have information on the biology, recruitment and distribution of important species in relation to ecological factors in space and time.

Series of publications are available on the prawn resources of India. Of them, the contributions made by Menon and Raman (1961) on the prawn fishery of Cochin backwaters; George (1964) on the breeding of penaeids and recruitment of their postlarvae and juveniles into the backwaters of Cochin; George (1973), Mohamed (1970), Rao (1973), Goswami et al. (1977), Muthu (1978) and Thampy et al. (1982) on postlarval studies of penaeid prawns; Rao (1972), Kuttyamma (1975), Selvakumar et al. (1977) and Suseelan and Kathirvel (1982) on seasonal abundance of prawn seeds from the estuarine and inshore waters off Cochin; and Kuttyamma and Antony (1975) on the size, sex and relative abundance of penaeid prawns in Cochin backwater are remarkable in this context.

The ecological imbalances and the environmental variations in water temperature, salinity, dissolved oxygen, rainfall and tidal current may account for the fluctuation in the prawn seed resources. Studies on physico-chemical features of the Cochin backwater system have been reported by Balakrishnan (1957), Ramamirtham and Jayaraman (1963), Qasim and Reddy (1967), Cherian (1967), Sankaranarayanan and Qasim

(1969), Josanto (1971) and Wellershaus (1973). Studies on the diurnal variation of environmental parameters and organisms in the estuaries and backwaters of India are limited to Godavari estuarine system (Subrahmanyam, 1965; Chandramohan and Rao, 1972); Vellar estuary (Rangarajan, 1958; Vijayalakshmi and Venugopal, 1974); Mandovi estuary (Goswami, 1974); Zuari estuary (Dehadri, 1970; Singbal, 1973); and Cochin backwater (George and Kartha, 1963; Qasim and Gopinathan, 1969; Shynamma and Balakrishnan, 1973; Pillai and Pillai, 1974; MPEDA, 1980; Ravindran, 1983); while diurnal variations on prawn seeds have been reported by Subrahmanyam (1965) from Godavari estuarine system; Goswami and George (1978) from the estuarine and near-shore waters of Goa; MPEDA (1980) in a Project Report on the assessment of fry resources of cultivable penaeid prawns at selected centres in Kerala and Karnataka and by Ramamurthy (1982) on the prawn seed resources of the estuaries in the Mangalore area.

Perusal of literature further indicated that since 1980, intensive and comprehensive studies on these juvenile prawn resources, accompanied by ecological features, from the Cochin backwater system, especially during monsoon season are lacking. Further, monsoon fishery in the estuarine system is particularly significant since it gives certain amount of livelihood to fishermen at a time when mechanised fishing activities in the sea are much reduced. This leads to overexploitation of prawn nursery grounds in these estuarine areas.

Thus, the factors such as decrease in the expanse of Cochin backwater, increase in demand for seed resources for culture practices, man-made ecological changes occurring in the environment, overexploitation of prawn nursery beds and decline in the estuary-dependent prawn fishery resources, stress the necessity for detailed investigation and to monitor the biological and ecological characteristics on the ecosystem for better evaluation and judicious exploitation of the resources.

The present study deals with the size distribution and abundance of cultivable penaeid prawns, particularly on the seed and juveniles of P. indicus, M. dobsoni and M. monoceros in the Ernakulam channel of Cochin backwater system, accompanied by hydrological features prevailing during southwest monsoon season, commencing from June to September 1987. The study aims at a comprehensive understanding of the pattern of recruitment in the estuary, delineating the reasons for the abundance, fluctuation and disappearance of size groups; and quantitative assessment of cultivable prawn seed and juvenile fishery resources in the shallow backwater areas adjoining Cochin city.

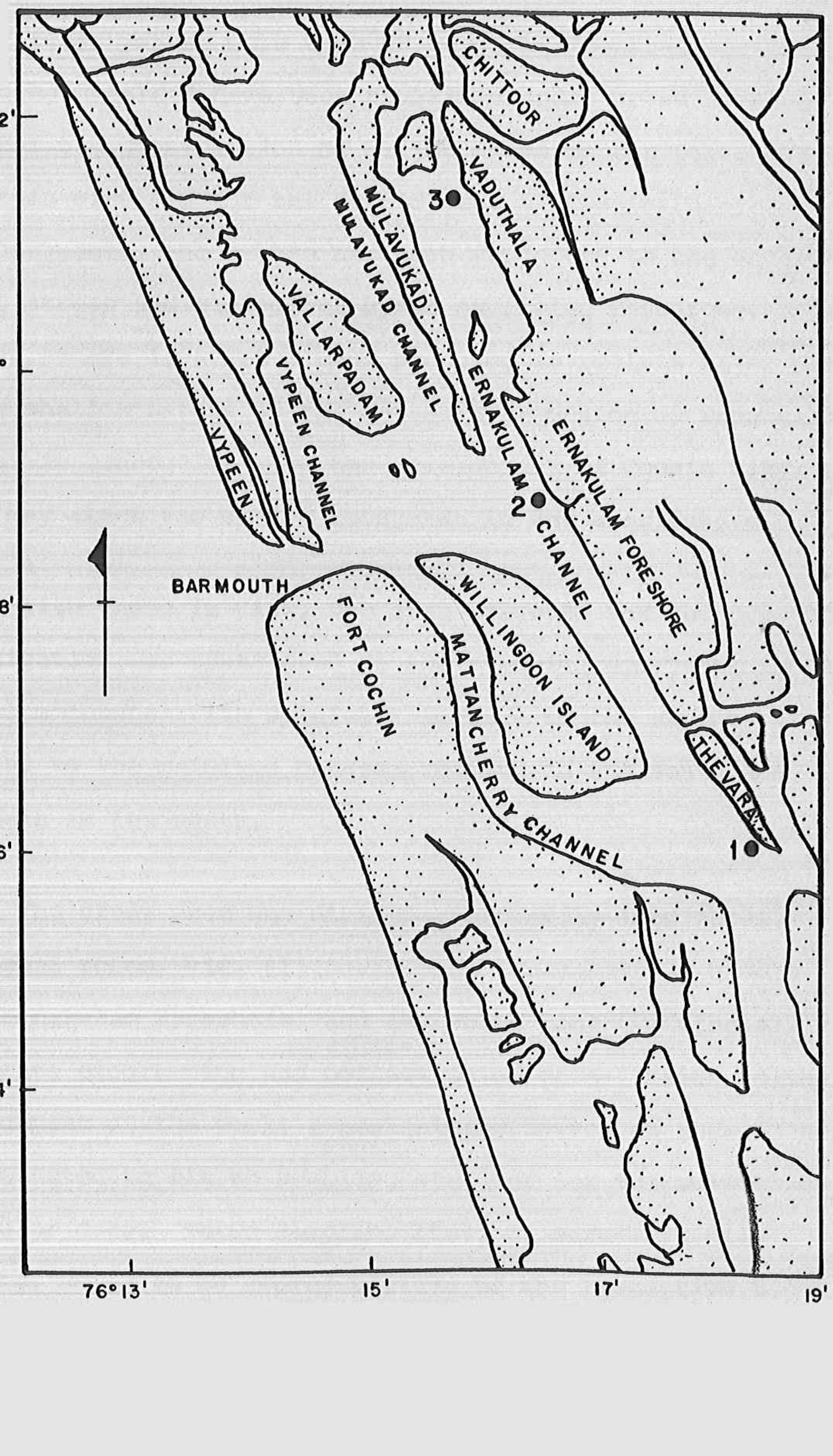
MATERIAL AND METHODS

'The Vembanad estuarine system', also called the 'Cochin backwater system', having the Vembanad Lake in its south and Cochin backwater in the north, extends between Alleppey and Azhikode (between latitude 09° 32' and 10° 12' N and longitude 76° 10' and 76° 29' E). It is the largest estuarine system of its kind on the west coast of India having permanent sea connection at Cochin and Azhikode. The backwater is subjected to strong tidal influence and mixing of fresh water influxes thus providing a brackishwater body in general and this would be of almost freshwater condition in its northern and southern regions for about four months in a year during the southwest monsoon.

The southern sector of the backwater in Cochin region may be arbitrarily divided into 'Mattancherry Channel' and 'Ernakulam Channel' separated by Willingdon Island; and similarly the northern sector from the barmouth into 'Vypeen Channel', 'Mulavukad Channel' and 'Northern extension of Ernakulam Channel' as separated by Vallarpadam and Mulavukad islands respectively. The Ernakulam Channel, thus forming a part of the Cochin backwater, lies adjacent to the main land of Cochin city.

As regards this backwater, the most serious alteration taking place is the progressive shrinkage of the system as a

Fig. 1. MAP SHOWING SAMPLING STATIONS

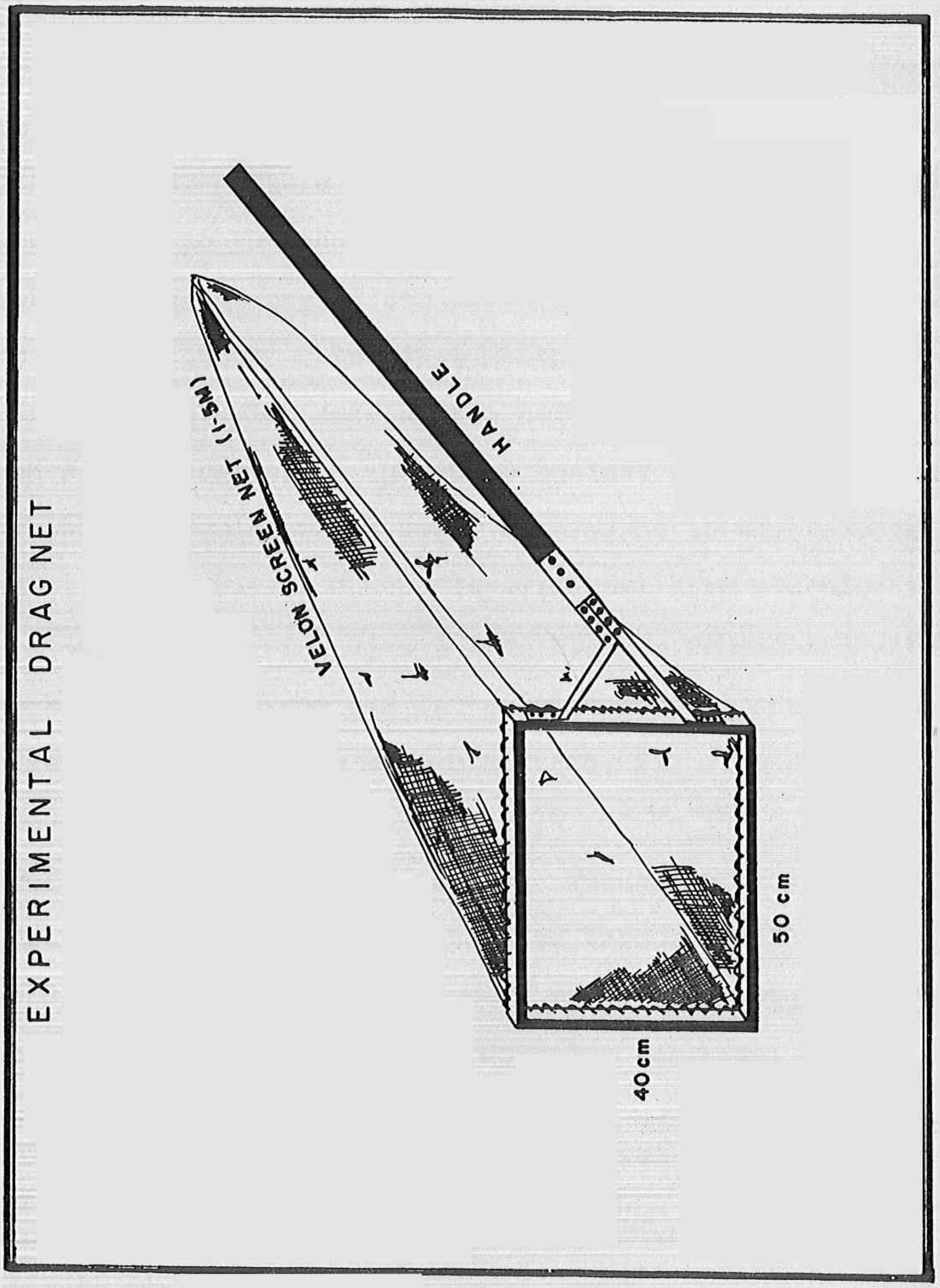


result of man-made reclamations and siltations. During the last fifteen years, more than 23 ha of its coastal periphery adjoining mainland have been reclaimed under urban development for the construction of marine drive on the foreshore of Cochin city and for the development of Cochin Shipyard. In consequence, the system has been subjected to the environmental stress and ecological upset on living resources. Further, there is a super plan proposed to reclaim major part of the shallow waters of the northern extension of Ernakulam channel in connection with the development of Cochin city, which may alter the entire ecosystem in the near future.

With these in view, the area selected for the present investigation was restricted to the changing ecosystem in the Ernakulam channel with special reference to the shallow areas adjacent to the mainland between Thevara in the south and Vaduthala in the north.

The study area was divided arbitrarily into three functional zones, viz. (1) South Zone (Thevara) (2) Middle Zone (Ernakulam foreshore) and (3) North Zone (Vaduthala), to facilitate programming and collection of data. Prior to the commencement of the work, a preliminary survey of these zones was conducted to fix up sampling stations for the collection of regular data. Three sampling stations were carefully selected, so as to be representative of the respective zones (Fig. 1).

Fig. 2


EXPERIMENTAL DRAGNET
HANDLE
VELON SCREEN NET (1-5M)
50 cm
40cm

Collection of data

Standard velon screen drag net (VN) and experimental drag net (DN) were employed for qualitative and quantitative estimation of penaeid prawn seed resources and their size composition in the shallow areas of less than one metre depth. Regular data on the prawn seed were collected from the three stations twice in a month at every fortnight by operating the velon screen drag net of 2 x 1 m, with 1 mm mesh size, parallel to the shore against water flow by two persons for 5 minutes to cover an area of 10 square metres; and by the operation of the experimental drag net of 50 x 40 cm mouth size with a long handle, fabricated with thick Aluminium frame and fitted with conical shaped velon screen bag net of 1 mm mesh size (Fig. 2). The net was dragged along the shore by a single person for a minute to cover an area of 2 square metres. To keep uniformity in sampling, same persons were engaged throughout the course of field work. The prawn seeds were sorted out and preserved separately in 5% formalin for detailed analysis.

To study the size composition, sex ratio and relative abundance of penaeid prawn juveniles from this ecosystem, fortnightly random samples of prawns were collected from landing centres of the respective zones from the prawn heaps brought by different canoes. Gear-wise sampling was not successful in these landing centres at all times since the catches were often mixed up. Since there was no fishing operation at zone-2 during the period of investigation, such data could not be collected from this zone.

Considering the availability and abundance of prawn seed, diurnal observations were carried out at station 1 (south zone) and 3 (north zone) in the last week of every month during southwest monsoon season, and bihourly collection of prawn seeds and hydrographic data on temperature, salinity and dissolved oxygen were made from 0600-1800 hours. Prawn seed samples were collected using VN and DN, as described, from the shallow areas of less than one metre depth. To facilitate comparison of data, as far as possible, dates with almost same tidal pattern, such as the highest tide occurring in the afternoon, were selected for the monthly diurnal observations on prawn seed resources in relation to hydrographic features. Attempts were made to relate the penaeid prawn abundance and distribution pattern with tidal influence, local rainfall and depth.

For quantitative estimation of the penaeid prawn fishery resources consisting of juveniles, regular weekly data on the prawn landings were collected from the local landing centres of south and north zones.

The above observations and sampling were made during the southwest monsoon season commencing from June to September 1987 in the Ernakulam Channel of the Cochin backwater system.

Treatment of data

The prawn seeds thus collected from the three zones were treated zone-wise for their species composition, size distribution and quantitative estimation. Similarly, the fortnightly samples of prawn juveniles collected from the landing centres were sorted out group-wise (Penaeids and non-penaeids) and species-wise number and weight were recorded for penaeids; sex-wise length measurements were taken for the cultivable species; and the data were treated for their size distribution, sex ratio and relative abundance.

Studies on size distribution were based on seed data and fishery data and a class interval of 5 mm was considered. For the determination of sex, specimens below 55, 40, 40 and 45 mm in length for P. indicus, M. dobsoni, M. monoceros and M. affinis respectively were conveniently treated as 'indeterminates'. When the sample was appreciably larger, sub-sample (at random) was considered for measurement and sex determination. The relative abundance of penaeid prawn juveniles were determined by number as well as by weight and treated for fortnightly and monthly representation.

The seed data collected during monthly diurnal observations were used for correlating their abundance with hydrographic parameters and in the quantitative estimation of penaeid prawn seed resources in the shallow belt of this ecosystem. The fishery data collected on juveniles were processed for fortnightly and monthly representation to assess the fishery potential of north and south zones based on the indices of abundance of landings during southwest monsoon months.

Environmental data on tidal amplitude, water temperature, salinity, dissolved oxygen, local rainfall and depth were taken into account in the present investigation to study whether these parameters have any remarkable relationship with the abundance and distribution of penaeid prawns in the ecosystem. Rainfall data was collected from the daily weather chart of Cochin airport area. For the present study, depth and tidal amplitude were recorded from the wooden poles fixed at the north and south zones for diurnal studies; water temperature was measured at the site using 0-50°C thermometer; salinity of the water sample was determined by the titration method described by Strickland and Parsons (1968); and dissolved oxygen content of water sample was determined by the modified Winkler method as given by Strickland and Parsons (1968).

General conclusion made were based on specific observations derived from the zone-wise analysis and from the practical knowledge gained in the field.

RESULTS

1. THE ENVIRONMENT

As the physical and chemical properties of the estuarine waters exert considerable influence on the fauna and flora including the prawn seed and fishery resources present in these waterbodies, the data collected during southwest monsoon months on water temperature, salinity and dissolved oxygen, in respect of the shallow backwaters adjoining Cochin city, are presented hereunder (Table-1).

The Cochin backwater had local rainfall of 160 cm during the southwest monsoon season, with intermittent gap during second fortnight of July and first fortnight of September. The fortnightly rainfall data recorded from June to September were 234, 361, 250, 42, 122, 481, 10 and 100 mm in the order. A gradual slope with increase in depth (1.5-3.5 m) was recorded from north to south zone in the Ernakulam Channel.

Surface water temperature ranged between 28.0-33.0°C, 28.0-32.1°C and 27.9-32.4°C at north, middle and south zones with mean values of 30.2, 30.1 and 29.8°C respectively. Higher values were recorded at north zone during the season. Surface salinity varied between 0.1-3.5‰ in north zone (Stn. 3), 1.5-12.5‰ in middle zone (Station-2) and 0.4-13.3‰ in

Table: 1. Range of temperature, salinity and dissolved oxygen in the shallow waters of Ernakulam Channel in Cochin backwater

Month	Rain-fall (mm)	Zone	Temperature (°C)		Salinity (‰)		Dissolved oxygen (ml/L)	
			Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
June	595	NZ	28.4	31.9	0.30	0.49	3.55	6.33
		MZ	28.1	31.2	2.32	2.50	2.45	4.80
		SZ	28.1	29.7	0.56	2.10	2.80	4.40
July	292	NZ	28.0	33.0	0.68	3.50	2.56	7.00
		MZ	28.0	32.1	1.51	6.70	2.70	4.50
		SZ	29.5	32.4	2.05	13.30	3.51	6.09
August	603	NZ	28.0	31.9	0.09	1.17	2.07	4.54
		MZ	29.1	32.0	6.70	10.20	4.40	6.95
		SZ	27.9	29.9	0.39	0.65	2.16	3.50
September	110	NZ	28.5	32.1	0.21	0.25	3.60	6.30
		MZ	28.2	31.7	6.40	12.50	3.91	5.10
		SZ	28.5	31.8	0.63	1.27	4.30	6.50
June - September (Average)	1600	NZ	28.2	32.2	0.32	1.35	2.95	6.04
		MZ	28.4	31.8	2.73	7.98	3.37	5.34
		SZ	28.5	31.0	0.91	4.33	3.19	5.10

NZ: North Zone MZ: Middle Zone SZ: South Zone south zone (Station-1) with mean values of 0.84, 6.1 and 2.62‰ respectively. Dissolved oxygen values in the three stations ranged between 2.07-7.00, 2.45-6.95 and 2.16-6.50 ml/L with mean values of 4.50, 4.40 and 4.15 ml/L respectively. Higher values (> 6.00 ml recorded in all the stations.

2. SPECIES COMPOSITION

Postlarvae of penaeid prawns were identified from the collections made during monthly diurnal observations, by filtering 1000 litres of surface water from stations 1 & 3 at one metre depth. The volume of water was filtered manually at speed through a zooplankton net (0.33 mm mesh) by means of a plastic bucket of 20 L capacity at every two hours interval between 0600 and 1800 hrs. Hauling of zooplankton net could not be operated at all times due to certain technical difficulties.

Analysis of samples revealed that postlarvae of <u>M. dobsoni</u> were represented in all the four months while <u>M. monoceros</u> were recorded in June and August and <u>P. indicus</u> in August only. In general, the postlarvae were very few in number and the monthly overall bihourly collections between 0600 and 1800 hours in aggregate contained 2-7 postlarvae with their maximum during August and the least in September. They were recorded mostly in the early hours of high tide period.

The penaeid prawn seeds and juveniles obtained during the present study were identified based on the characteristics provided by Rao (1972,a) and Muthu (1978). Identification of the different species of juveniles was relatively easy in fresh condition based on the colouration of the body, shape of rostrum and rostral teeth formula. In the juveniles of genus Penaeus, the rostral teeth were present on the dorsal and ventral side of rostrum, while in Metapenaeus it is devoid of teeth on the ventral side of the rostrum.

The early juveniles of P. indicus could be identified in the field by their cream coloured body with numerous dark chromatophores, slender and elongated rostrum and by yellowish antennal flagella. The early juveniles of M. dobsoni were characterised by the transparent body, light pinkish elongated antennal flagella and also by the dagger-shaped short rostrum provided with a prominent basal crest. The early juveniles of M. monoceros were identified by the highly pigmented body with straight and pointed rostrum. The most significant feature of identification was the conspicuous 'M' shaped chromatophores on the mid-dorsal region of the fourth abdominal segment. The juveniles of *M. affinis* closely resemble that of *M. monoceros* except for less pigmentation and the absence of the 'M' shaped chromatophores on the mid-dorsal region. *M. affinis* was characterised by the abdominal carination starting from the fourth abdominal somite and by the length of the last pereopod which normally exceeds the base of antennular peduncle.

Although seven species of penaeid prawns, namely *Penaeus indicus* (Milne Edwards), *Metapenaeus dobsoni* (miers), *M. monoceros* (Fabricius), *M. affinis* (Milne Edwards) *Penaeus monodon* (Fabricius), *P. semisulcatus* (de Haan) and *Parapenaeopsis stylifera* (Milne Edwards) were recorded from Cochin backwater during the present study, juveniles of *P. indicus*, *M. dobsoni*, *M. monoceros* and *M. affinis* were available in considerable quantities. *M. dobsoni* was the dominant species during southwest monsoon months.

3. SIZE DISTRIBUTION

Seed data and fishery sample data were treated separately to study the size distribution pattern of penaeid prawn seeds and juveniles. Specimens measuring upto 50 mm for *P. indicus* and 35 mm each for *M. dobsoni* and *M. monoceros* were regarded as seeds (Suseelan and Kathirvel, 1982). The

Fig. 3a

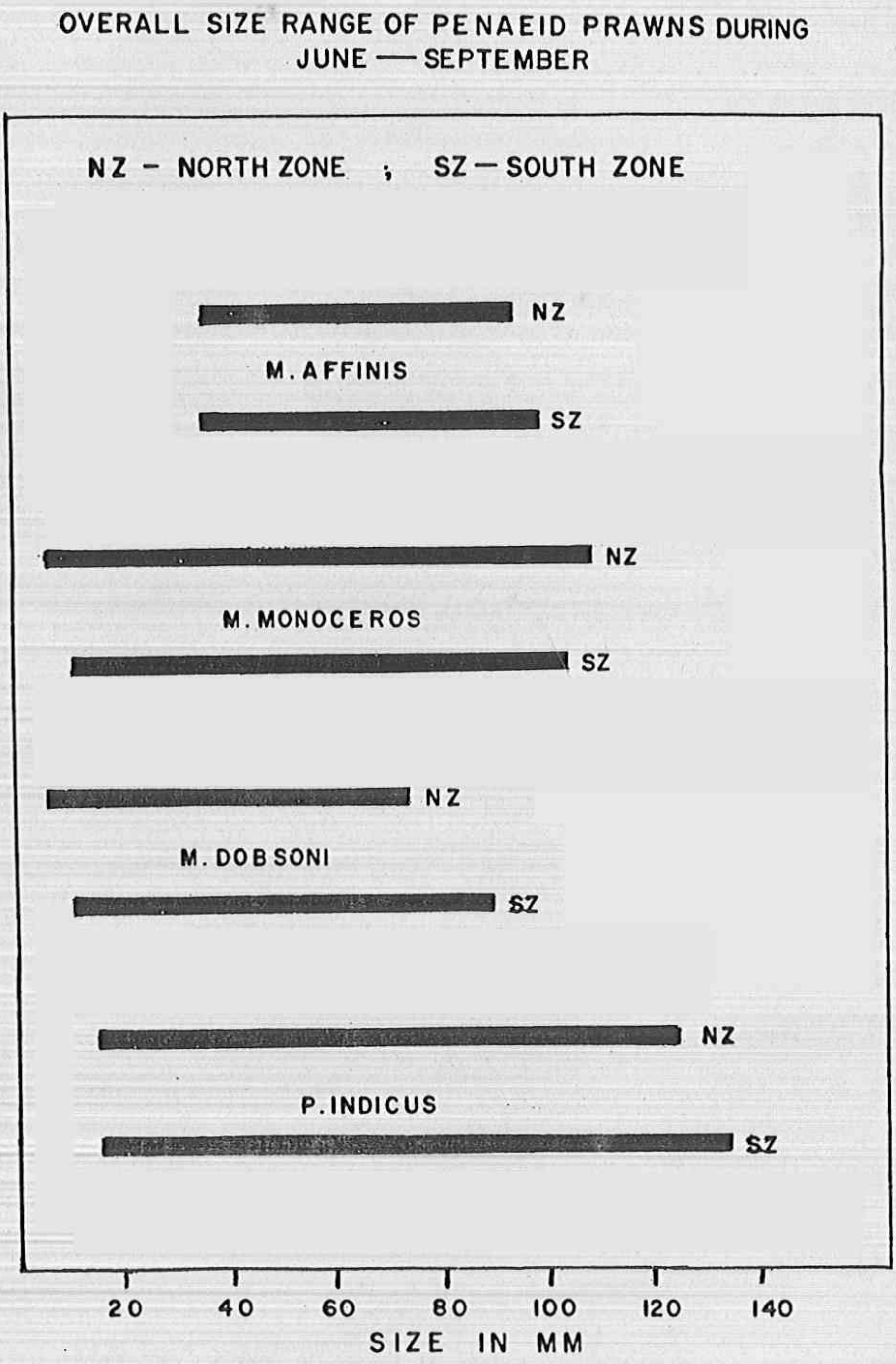
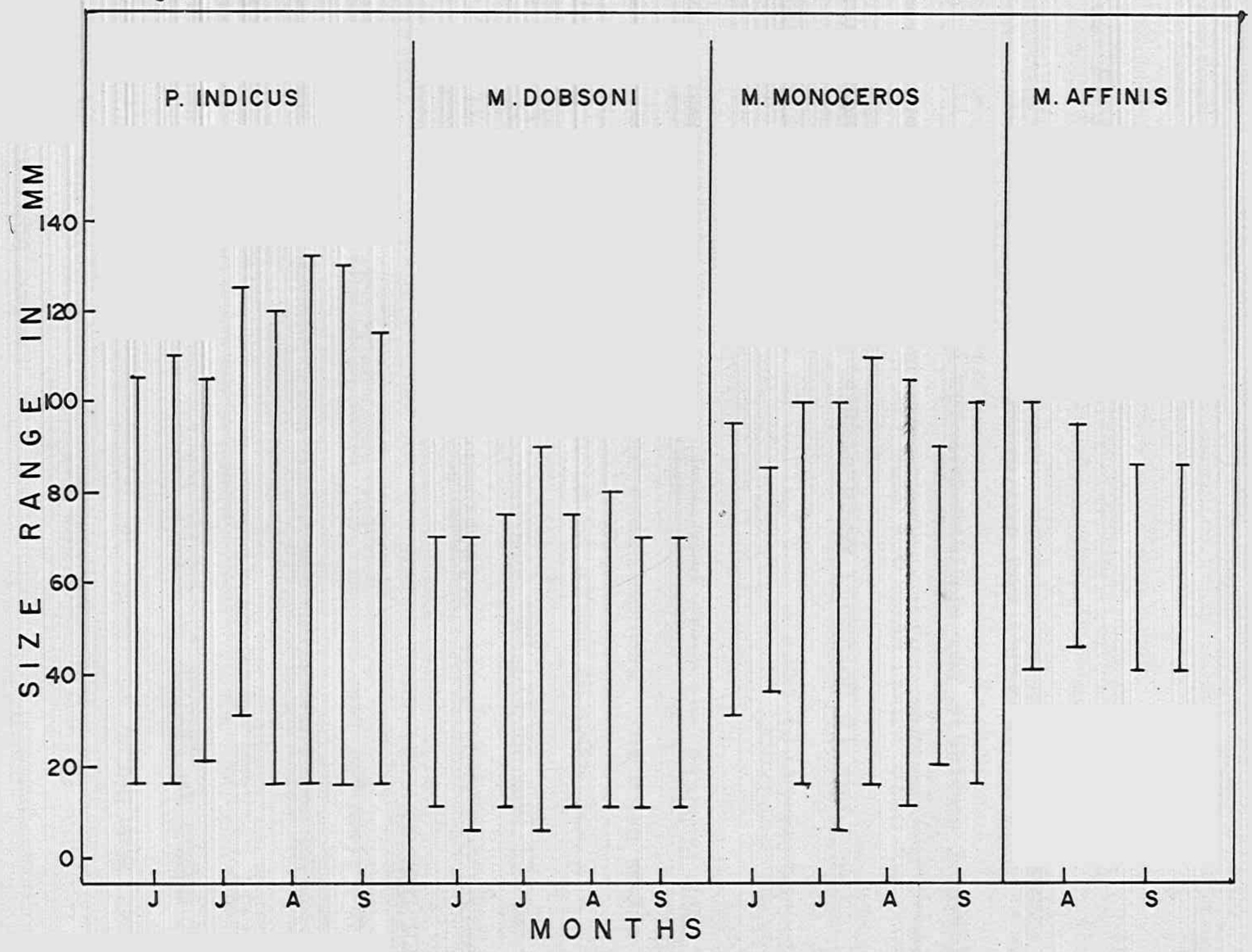

OVERALL SIZE RANGE OF PENAEID PRAWNS DURING
JUNE — SEPTEMBER
NZ - NORTH ZONE ; SZ — SOUTH ZONE
NZ
M. AFFINIS
SZ
NZ
M. MONOCEROS
SZ
NZ
M. DOBSONI
SZ
NZ
P. INDICUS
SZ
20
40
60
80
100
120
140
SIZE IN MM

Fig.3b. MONTHLY SIZE RANGE OF PENAEID PRAWNS



overall size range of penaeid prawns (excluding postlarvae) available in the backwater during southwest monsoon season is given in Figs. 3a & b.

3.1 P. indicus

The smallest size group for the three zones was 16-20 mm while 36-40 mm was the maximum for stations 1 and 3, and 31-35 mm for station 2; and the mean modal size for the south zone (station 1), middle zone (station 2) and the north zone (station 3) was 28 mm during the season (June-September).

The minimum size group recorded from the fishery data was 36-40 mm in both north and south zones. The mean modal size for the season was found to be 63 mm in both zones (Table 2). The maximum size recorded was 125 mm and 132 mm for north and south zones respectively. More than two modes were recorded during August in the north zone (53, 78 and 93 mm) and September in the south zone (63, 78, 88 and 113 mm). The data indicated a growth rate of 30 mm in 45 days (20 mm/month) through a progression of mode from 63 to 93 mm between first fortnight of July and second fortnight of August at north zone, which started disappearing in September beginning (Fig. 4). The size distribution was uneven during August-September at both zones.

Table 2. Size distribution of P. indicus in relation to depth

(Size range and modal size in mm; modal size given in paranthesis)

Period	Shallow areas (< 1 m depth)			Deeper areas (>1 m depth)	
	N. Zone	M. Zone	S. Zone	N. Zone	S. Zone
Fortnightly					
June I	21-35 (28)	No data	16-35 (23)	36-105 (53)	36-90 (53)
II	21-35 (28)	26-30 (28)	16-35 (28)	46-95 (73)	36-110 (63)
July I	26-40 (33)	26-30 (28)	21-30 (28)	56-95 (63)	41-105 (63)
II	31-40 (33)	26-35 (33)	31-40 (38)	66-125 (78)	66-120 (103)
Aug. I	26-40 (38)	21-35 (23,28)	16-40 (18,38)	86-120 (88,103)	91-120 (113)
II	16-30 (18)	16-25 (18)	21-30 (23)	51-95 (53,78,93)	51-135 (83)
Sept. I	16-40 (28)	16-21 (18)	21-35 (23,28)	56-105 (88)	46-130 (108)
II	16-25 (18,23)	16-30 (28)	21-30 (23,28)	81-105 (103)	61-115 (63,78, 88,113)
Monthly					
June	21-35 (28)	16-30 (28)	16-35 (23,28)	36-105 (53)	36-110 (63)
July	26-40 (33)	26-30 (28)	31-40 (33,38)	56-125 (63)	41-125 (103)
August	16-40 (18,38)	16-35 (18)	16-40 (18,38)	51-105 (88)	51-135 (83,113)
Sept.	16-35 (18)	16-30 (28)	21-30 (23,28)	56-105 (88)	46-126 (108)
Seasonal					
June-Sept.	16-40 (28)	16-35 (28)	16-40 (28)	36-125 (63)	36-132 (63)
	—— Seed data	——	——	—— Fishery data	——

Fig. 4. SIZE DISTRIBUTION OF PENAEUS INDICUS

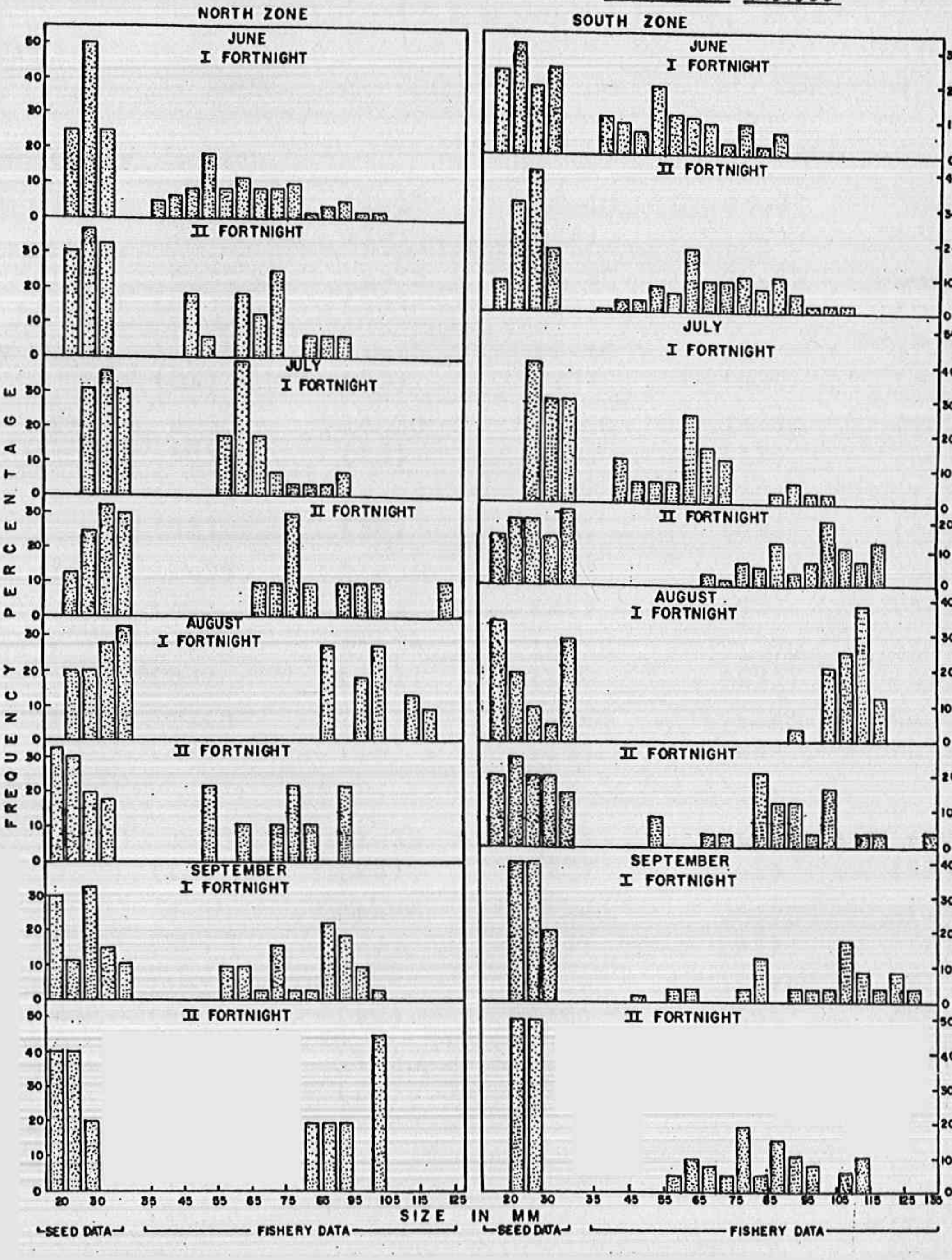
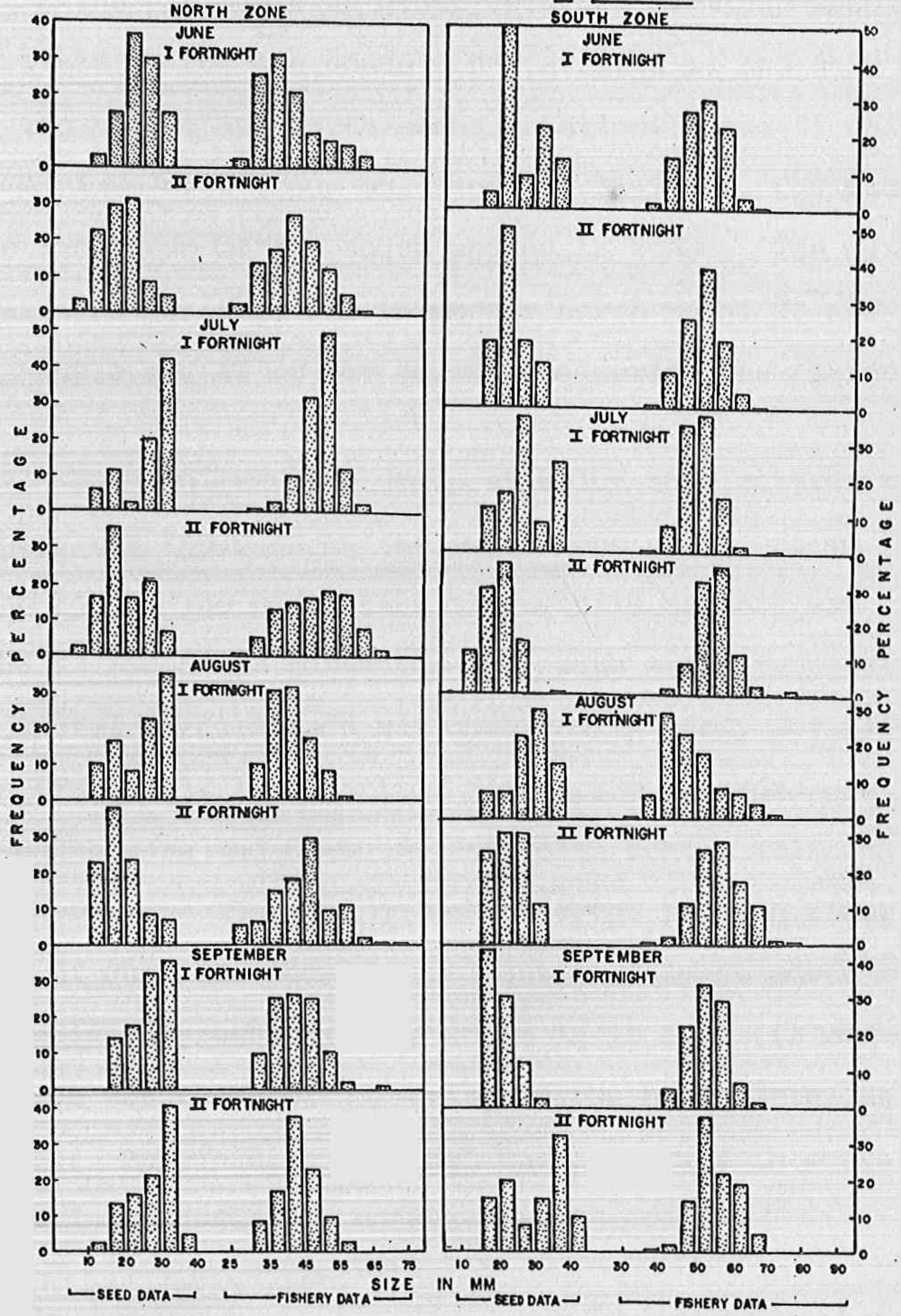


Table 3. Size distribution of M. dobsoni in relation to depth

(Size range and modal size in mm; modal size given in paranthesis)

Period	Shallow areas (< 1 m depth)			Deeper areas (>1 m depth)	
	N. Zone	M. Zone	S. Zone	N. Zone	S. Zone
Fortnightly					
June I	11-35 (23)	11-35 (18)	16-40 (23)	26-65 (38)	36-70 (53)
II	6-35 (23)	6-35 (23)	16-35 (23)	26-65 (43)	36-70 (53)
July I	11-35 (33)	11-35 (23)	16-40 (28)	31-65 (53)	31-75 (53)
II	6-35 (18)	16-30 (23)	11-40 (23)	26-70 (53)	41-90 (58)
Aug. I	11-35 (33)	16-35 (28)	16-40 (33)	26-60 (43)	31-75 (43)
II	11-35 (18)	11-35 (23)	16-35 (23)	26-75 (48)	36-80 (58)
Sept. I	16-35 (33)	11-35 (28)	16-35 (18)	31-70 (43)	41-70 (53)
II	11-40 (33)	11-35 (18)	16-40 (38)	31-60 (43)	36-70 (53)
Monthly					
June	6-35 (23)	11-35 (23)	16-40 (23)	26-65 (43)	36-70 (53)
July	6-35 (28)	11-35 (23)	11-40 (23)	26-70 (53)	31-90 (53)
Aug.	11-35 (18)	11-35 (28)	16-40 (28)	26-75 (38)	31-80 (53)
Sept.	11-40 (33)	11-35 (28)	16-40 (18)	31-70 (43)	36-70 (53)
Seasonal					
June-Sept.	6-40 (18)	11-35 (23,28)	11-40 (23)	26-75 (43)	31-90 (53)
	——Seed data——			—Fishery data—	

Fig. 5. SIZE DISTRIBUTION OF M. DOBSONI



3.2 M. dobsoni

The minimum size group recorded from the seed data was 11-15 mm for the south zone (station 1) and 6-10 mm for the middle and north zones (stations 2 and 3) while the maximum size group observed was 31-35 mm, for middle zone and 36-40 mm for south and north zones. The mean modal size obtained was 18 mm for north zone, 23 and 28 mm for middle and 23 mm for south zone during the season.

The minimum size group at which they entered the fishery was 26-30 mm in the north zone and 31-35 mm for the south zone. The modal size of juvenile fishery was found to be 43 and 53 mm for north and south zones respectively. In general, single mode was observed in every fortnightly data (Table 3). The maximum size group recorded was 71-75 mm for north zone and 86-90 mm for south zone. Shifting of a peak mode from 38 to 58 mm was observed between first fortnight of June and second fortnight of July at north zone indicating a growth rate of 20 mm in 45 days (13 mm/month). The mode was found disappearing in the next fortnight (Fig.5). Progression of modes was not clear in south zone and during Aug-Sept at both zones.

3.3 M. monoceros

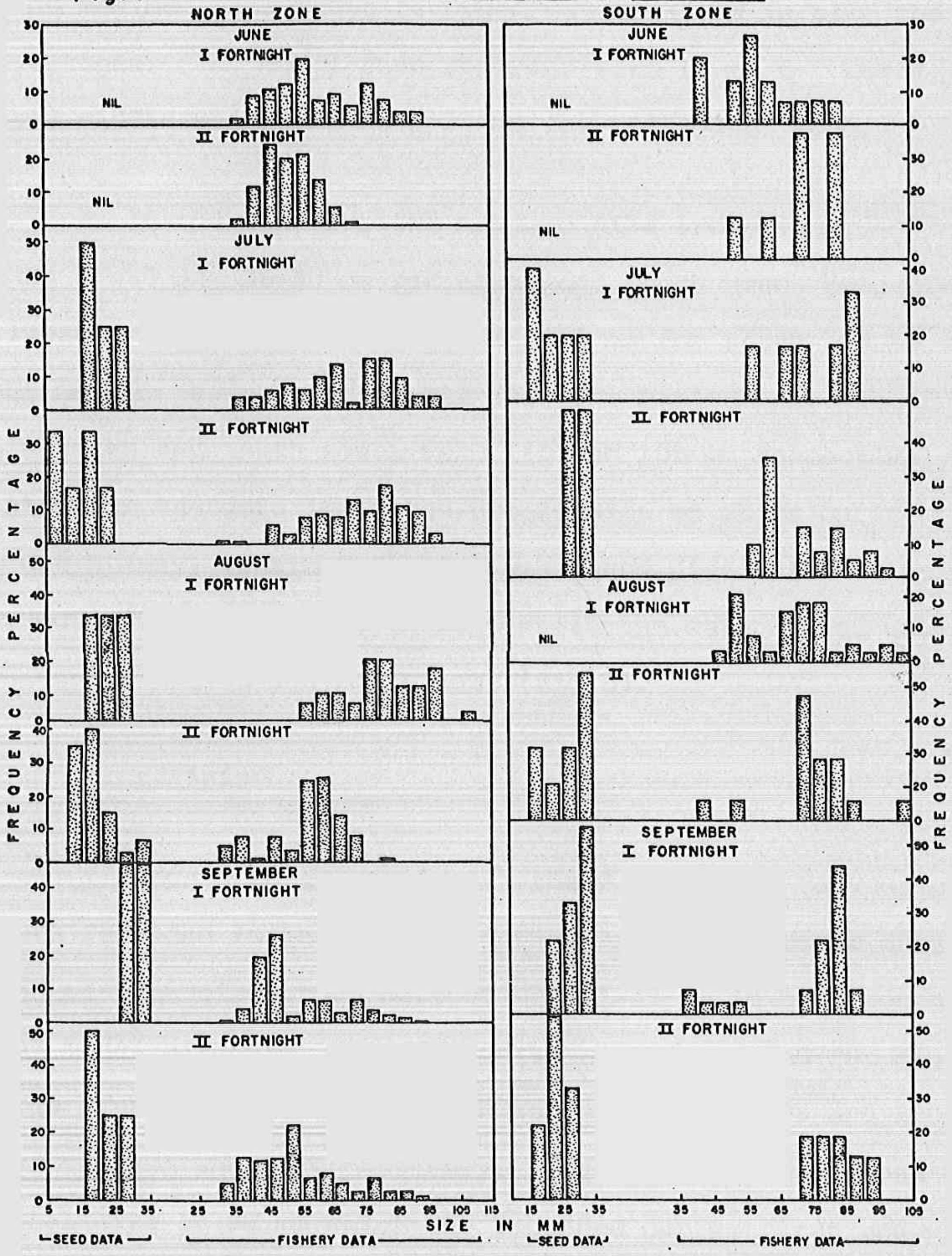
The minimum size group recorded in seed collection was 6-10 mm from north zone (station 3); whereas it was

Table 4. Size distribution of M. monoceros in relation to depth

(Size range and modal size in mm; modal size given in paranthesis)

Period		Shallow areas(< 1m depth)			Deeper areas (> 1 m depth)	
		N. Zone	M. Zone	S. Zone	N. Zone	S. Zone
Fortnightly						
June	I	--	--	--	31-95 (58)	41-85 (58)
	II	--	--	--	36-75 (48)	51-85 (73,83)
July	I	16-30 (18)	16-20 (18)	16-35 (18)	36-100 (78,83)	56-90 (88)
	II	6-30 (8,18)	16-20 (18)	26-35 (28,33)	31-100 (83)	56-100 (63)
Aug.	I	16-30 (18,23,28)	16-30 (23)	--	56-110 (78,83)	46-105 (53)
	II	11-35 (18)	16-35 (28)	16-35 (33)	31-85 (58,63)	41-105 (73)
Sept.	I	26-35 (28,33)	26-35 (28,33)	21-35 (33)	31-95 (48)	36-90 (83)
	II	16-30 (18)	16-25 (18,23)	16-30 (23)	36-100 (53)	71-95 (73,78,83)
Monthly						
June		--	--	--	31-95 (58)	41-85 (58,83)
July		6-30 (18)	16-20 (18)	16-35 (28,33)	31-100 (83)	56-100 (63)
Aug.		11-30 (18)	16-35 (28)	16-35 (33)	31-110 (68)	41-105 (73)
Sept.		16-35 (18)	16-35 (18,33)	16-35 (23,28)	31-95 (48)	36-100 (83)
Seasonal						
June-Sept.		6-35 (18)	16-35 (18)	16-35 (28,33)	31-110 (53,58)	31-105 (73,83)
		Seed data			Fishery data	

Fig. 6. SIZE DISTRIBUTION OF METAPENAEUS MONOCEROS



16-20 mm for the middle and south zones (stations 2 & 1). The maximum size group recorded was 31-35 mm in all the stations. The modal size recorded were 18 mm for north and middle zones and 28 & 33 mm for the south zone.

In the fishery, the minimum size group recorded was 31-35 and 36-40 mm for north and south zones respectively. The modal size were 53 & 58 mm for north and 73 & 83 mm for south zone (Table 4). The maximum size recorded in north and south zones were 110 and 105 mm respectively. Although the data indicated progression of modes during June & July, tracing of modes was found difficult due to successive modes at north zone while the data showed uneven distribution in the south zone (Fig.6).

3.4 *M. affinis*

Seeds were absent in all the 3 stations. Juveniles were recorded in the fishery during August-September only. The minimum size group noticed was 41-45 mm in both zones; the modal size was 63 mm for north and 68 & 73 mm for south zone (Table 5). The maximum size recorded was 95 and 100 mm for the two zones respectively. The data indicated that the modal size at 88 mm which was recorded during first and second fortnight of August for south and north zones respectively were exclusively absent in the following fortnights

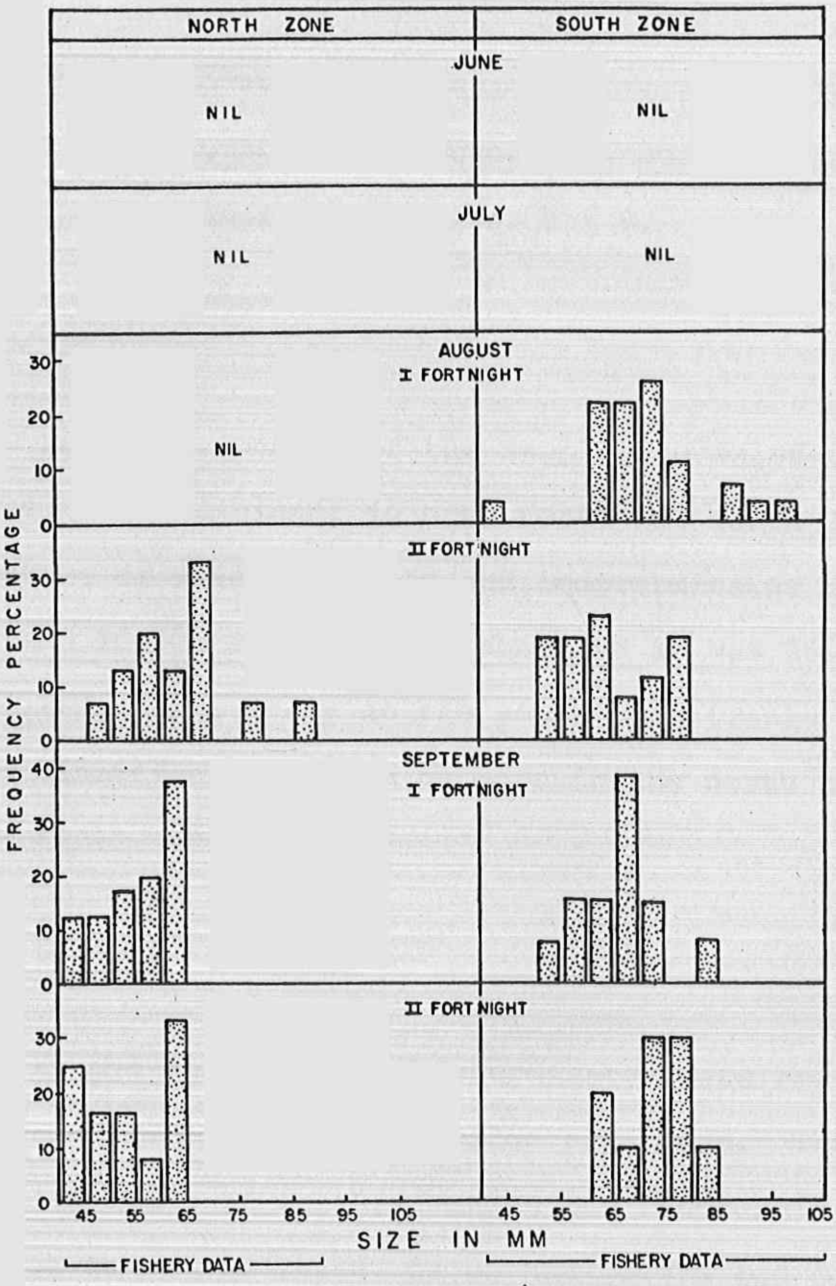
Table 5. Size distribution of M. affinis in relation to depth

(Size range and modal size in mm; modal size given in paranthesis)

Period		Shallow areas(< 1m depth)			Deeper areas(>1 m depth)	
		N. Zone	M. Zone	S. Zone	N. Zone	S. Zone
Fortnightly						
June	I	Nil	Nil	Nil	Nil	Nil
	II	"	"	"	"	"
July	I	"	"	"	"	"
	II	"	"	"	"	"
Aug.	I	"	"	"	"	41-100 (73)
	II	"	"	"	46-95 (68)	51-80 (63)
Sept.	I	"	"	"	41-65 (63)	51-85 (68)
	II	"	"	"	41-65 (63)	61-85 (73,78)
Monthly						
June		"	"	"	--	--
July		"	"	"	--	--
Aug.		"	"	"	46-95 (68)	41-100 (63)
Sept.		"	"	"	41-65 (63)	51-85 (68)
Seasonal						
June-Sept.		"	"	"	41-95 (63)	41-100 (68,73)

____ Seed data ____ ___ Fishery data ___

Fig. 7. SIZE DISTRIBUTION OF M. AFFINIS



during August-September (Fig.7

4. SEX DISTRIBUTION

Sex-ratio and distribution pattern of males and females of P. indicus, M. dobsoni, M. monoceros and M. affinis are depicted in Figs. 8 & 9.

4.1 P. indicus

Sex distribution of the samples revealed that female population was dominant in both north and south zones. The percentage of males, females and indeterminates was 20.07, 59.03 and 20.90% in the north zone and it was 26.16, 57.58 and 16.26% respectively in the south zone (Table 6 & Fig.8). Indeterminates appeared to be more in the north zone than in the south zone.

4.2 M. dobsoni

In the north zone, indeterminates were abundant; whereas in the south zone, females were more. The percentage distribution of males, females and indeterminates in the north zone was 21.34, 27.69 and 50.97% and for the south zone 40.76, 54.56 and 4.68% respectively. Combination of the data indicated that females were dominant, in general, in the surveyed ecosystem (Table 6 & Fig. 8).

Table 6. Sex-wise distribution of Penaeid prawns (%)
(Fishery data)

Month	Sex	Monthly Average N. Zone	Monthly Average S- Zone	Season's Average (June-September) N. Zone	Season's Average (June-September) S. Zone	(N + S Zones)
			Penaeus indicus			
	M	5.48	16.33			
June	F	56.16	50.34	M = 20.07	26.16	23.12
	I	38.36	33.33			
	M	31.70	33.73			
July	F	48.08	54.22	F = 59.03	57.58	58.30
	I	19.50	12.05			
	M	33.33	27.66			
Aug.	F	55.56	68.08	I = 20.90	16.26	18.58
	I	11.11	4.26			
Sept.	M	9.76	26.92			
	F	75.61	57.69			
	I	14.63	15.38			
			Metapenaeus dobsoni			
	M	17.11	31.02			
June	F	26.24	63.19	M = 21.34	40.76	31.05
	I	56.65	5.79			
	M	35.36	40.87			
July	F	44.06	56.12	F = 27.69	54.56	41.13
	I	20.58	3.01			
	M	14.74	42.73			
Aug.	F	25.79	49.55	I = 50.97	4.68	27.82
	I	59.47	7.72			
	M	18.15	48.39			
Sept.	F	14.67	49.39			
	I	67.18	2.22			

.. Contd ..

Table 6 contd.

Month	Sex	Monthly Average N. Zone	Monthly Average S. Zone	Season's Average (June-September) N. Zone	S. Zone	(N + S Zones
		Metapenaeus monoceros				
	M	20.62	40.00			
June	F	47.42	45.00	M = 28.50	39.93	34.21
	I	31.96	15.00			
	M	37.02	38.09			
July	F	51.93	61.91	F = 43.54	53.93	48.74
	I	11.05	--			
Aug.	M	31.03	36.84			
	F	54.31	60.53	I = 27.96	6.14	17.05
	I	14.66	2.63			
	M	25.35	44.83			
Sept.	F	20.48	48.28			
	I	54.17	6.89			
		Metapenaeus affinis				
	M	--	--			
June	F	--	--	M = 45.95	49.53	47.74
	I	--	--			
	M	--	--			
July	F	--	--	F = 38.54	50.47	44.51
	I	--	--			
Aug.	M	47.06	40.74			
	F	52.94	59.26	I = 15.51	--	7.75
	I	--	--			
	M	44.83	58.33			
Sept.	F	24.14	41.67			
	I	31.03	--			

M - Males F - Females I - Indeterminates

Fig. 8. SEX-WISE ABUNDANCE OF PENAEID PRAWNS

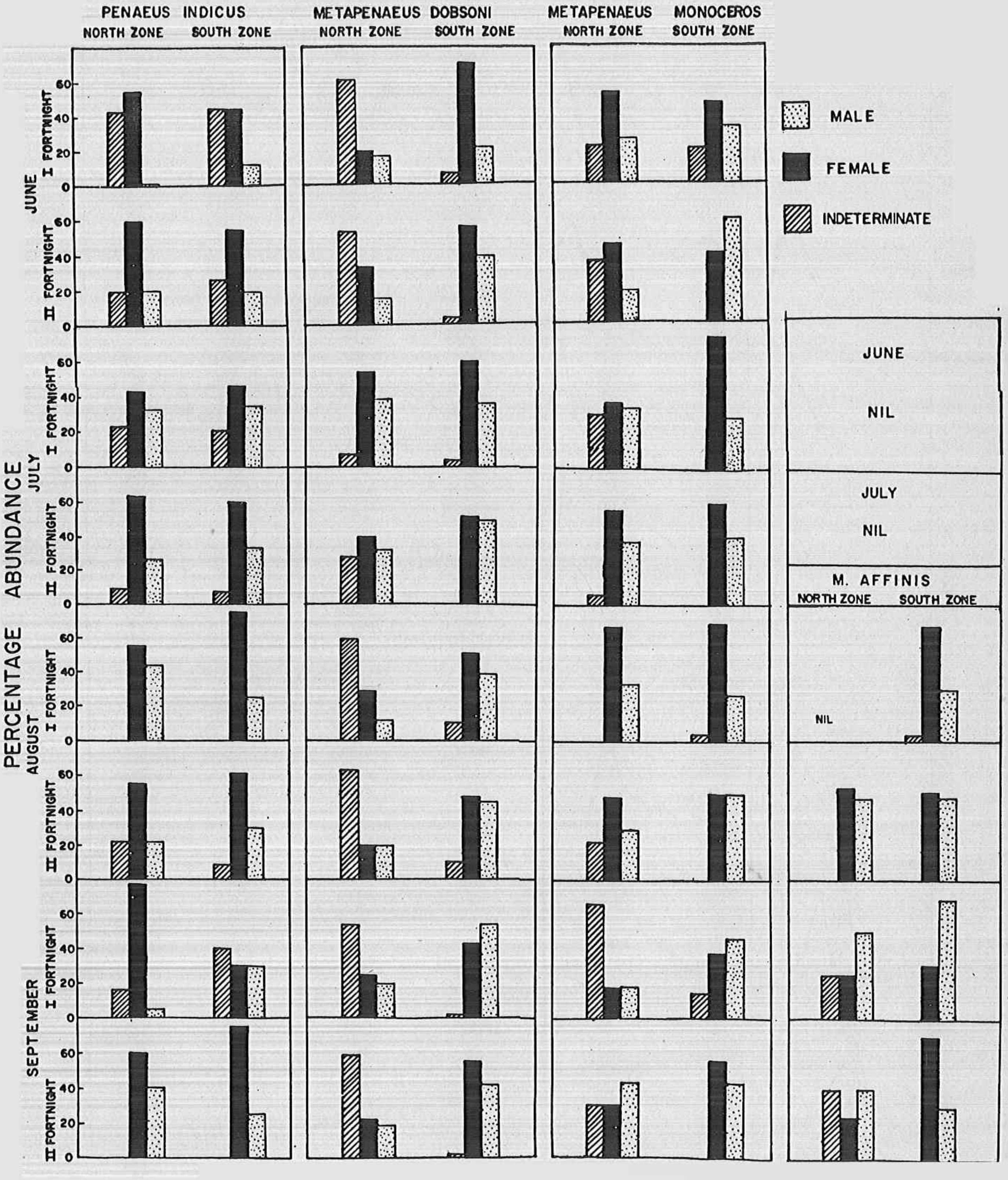
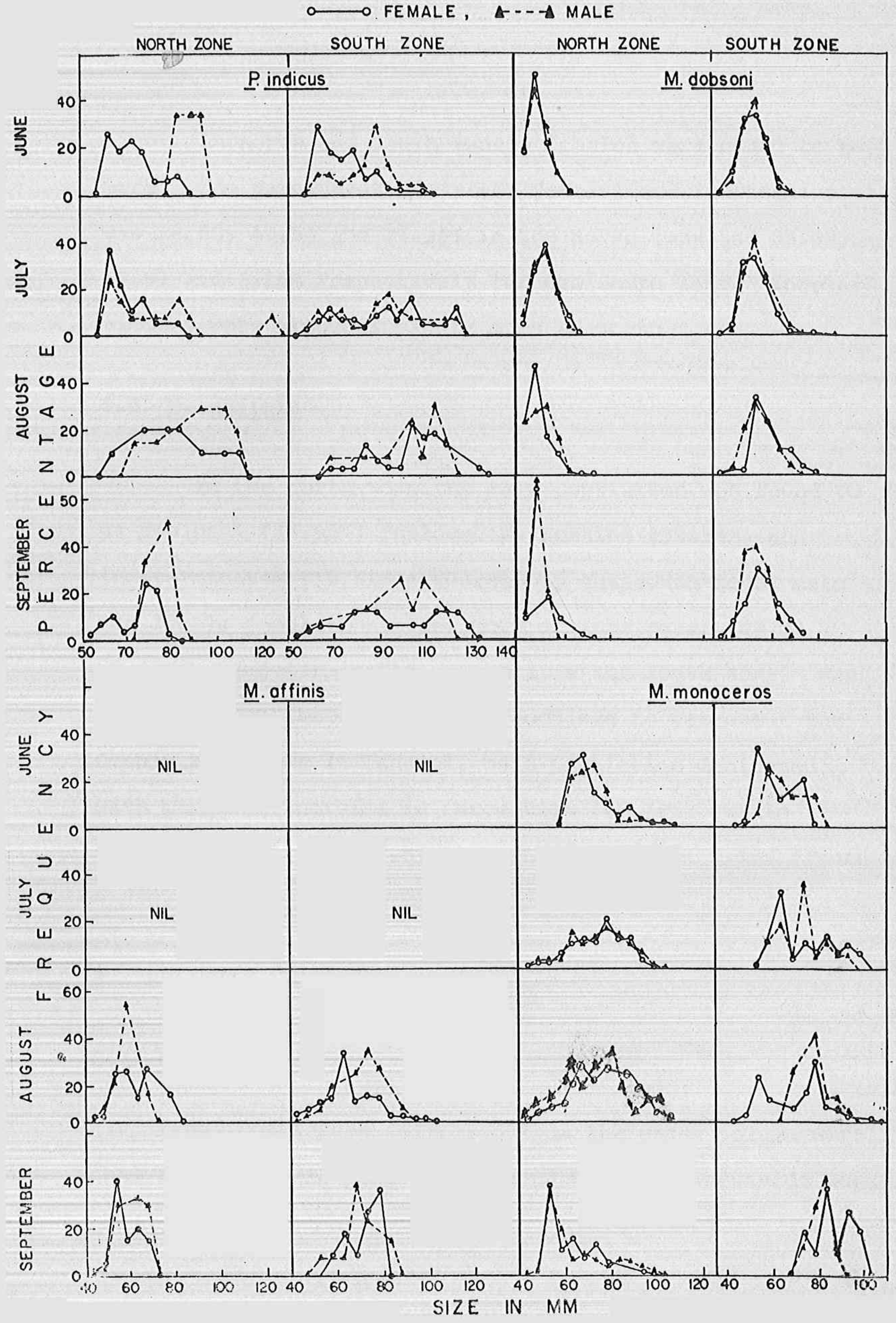


Fig. 9. SIZE DISTRIBUTION OF MALES AND FEMALES



4.3 *M. monoceros*

In north and south zones, females were found to be more. The percentage of males, females and indeterminates was 28.50, 43.54 and 27.96% in the north zone and 39.93, 53.93 and 6.14% respectively for the south zone. Indeterminates were proportionately more in north zone.

4.4 *M. affinis*

In the north zone the male population was found to be dominant (45.95%) followed by females (38.54%) and indeterminates (15.51%); whereas in the south zone, male and female populations were more or less equal (49.53 & 50.47%). Indeterminates were nil in the south zone. When the data from these zones were combined to represent the Cochin backwater in general, male population dominated with marginal increase in percentage (47.74%), while females constituted 44.51% and indeterminates 7.75% (Table 6 & Fig. 8).

5. RELATIVE ABUNDANCE

5.1 Seed samples

The postlarvae collected from the water column were analysed for their percentage abundance. Non-penaeids were not encountered in the collections. Among penaeids, M. dobsoni was 83.33 and 80.00% at north and south zones, while M. monoceros was 11.11 and 13.33% respectively. P. indicus larvae were rare and recorded during August only in the north and south zones at 5.56 and 6.6% by number.

Seed samples collected from the bottom of shallow areas of north and south zones indicated that the total penaeid seeds were 93.5 and 79.2% of the collections, in which, P. indicus constituted 0.55 and 18.79%, M. dobsoni 96.96 and 78.16% and M. monoceros 2.39 and 2.95% respectively.

5.2 Fishery samples

Based on the analysis of prawn fishery samples (juveniles) collected from the landing centres of north and south zones, month-wise relative abundance of cultivable penaeid prawn species available during south-west monsoon months was studied with reference to their number and weight and the results are given in Table 7 and Figs. 10-13.

5.2.1 Abundance by number

The total prawns (penaeids and non-penaeids) constituted about 95% at both north and south zones; of this,

Table 7. Relative abundance of Penaeid prawn juveniles by number and weight

		By Number (%)					By Weight (%)				
		Monthly Ave.		Season's Ave.		Surveyed area ave. (N+S)	Monthly Ave.		Season's Ave.		Surveyed Area average (N+S)
Species	Month	North Zone	South Zone	North Zone	South Zone		North Zone	South Zone	North Zone	South Zone	
Penaeid prawns in total (P&NP)	June	93.51	92.74	94.56	94.74	94.65	91.26	97.59	86.31	96.76	91.54
	July	96.97	94.55				89.24	95.74			
	Aug.	93.58	92.63				77.32	94.96			
	Sept.	94.19	99.04				87.41	98.74			
P. indicus	June	9.63	32.22	6.32	14.30	10.3	41.87	34.19	20.73	29.27	25.0
	July	5.87	9.73				11.10	20.86			
	Aug.	2.95	9.23				14.02	35.76			
	Sept.	6.81	6.01				15.93	26.26			
M. dobsoni	June	68.58	63.30	67.58	73.98	70.8	25.49	56.28	34.05	51.96	43.0
	July	75.84	85.08				44.95	69.19			
	Aug.	73.60	66.95				35.11	34.77			
	Sept.	52.35	80.62				30.66	47.59			
M. monoceros	June	21.79	4.48	24.28	7.52	15.9	32.64	9.53	42.61	13.20	27.9
	July	18.29	5.19				43.95	9.95			
	Aug.	20.46	12.21				43.59	15.78			
	Sept.	36.57	8.19				50.25	17.55			
M. affinis	June	--	--	1.82	4.20	3.0	--	--	2.61	5.57	4.1
	July	--	--				--	--			
	Aug.	2.99	11.61				7.28	13.69			
	Sept.	4.27	5.18				3.16	8.60			

P & NP - Penaeid and Non-penaeid prawns

Fig.11

MONTHLY TREATMENT-RELATIVE ABUNDANCE (BY NUMBER)

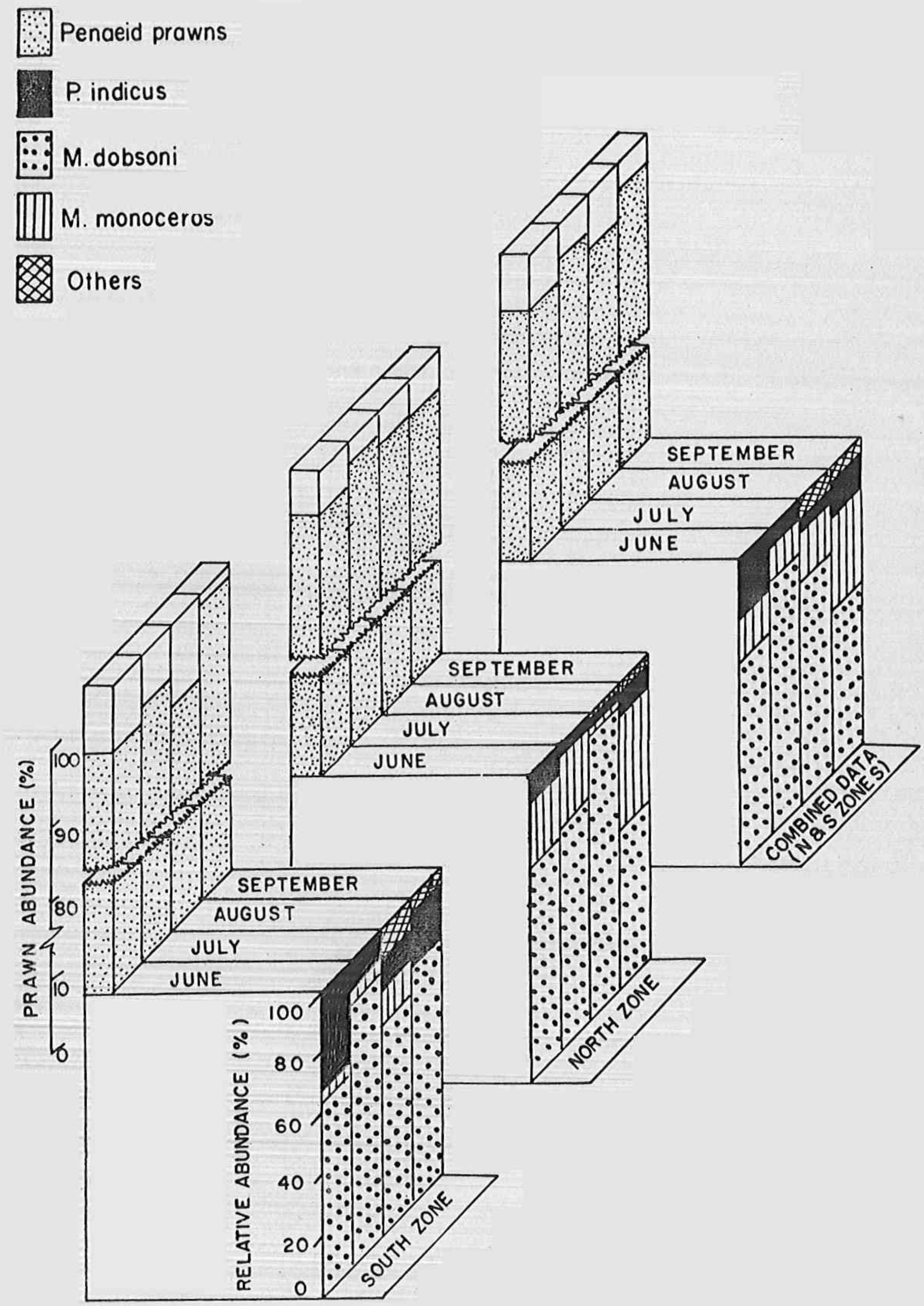


Fig. 12

MONTHLY TREATMENT- RELATIVE ABUNDANCE (BY WEIGHT)

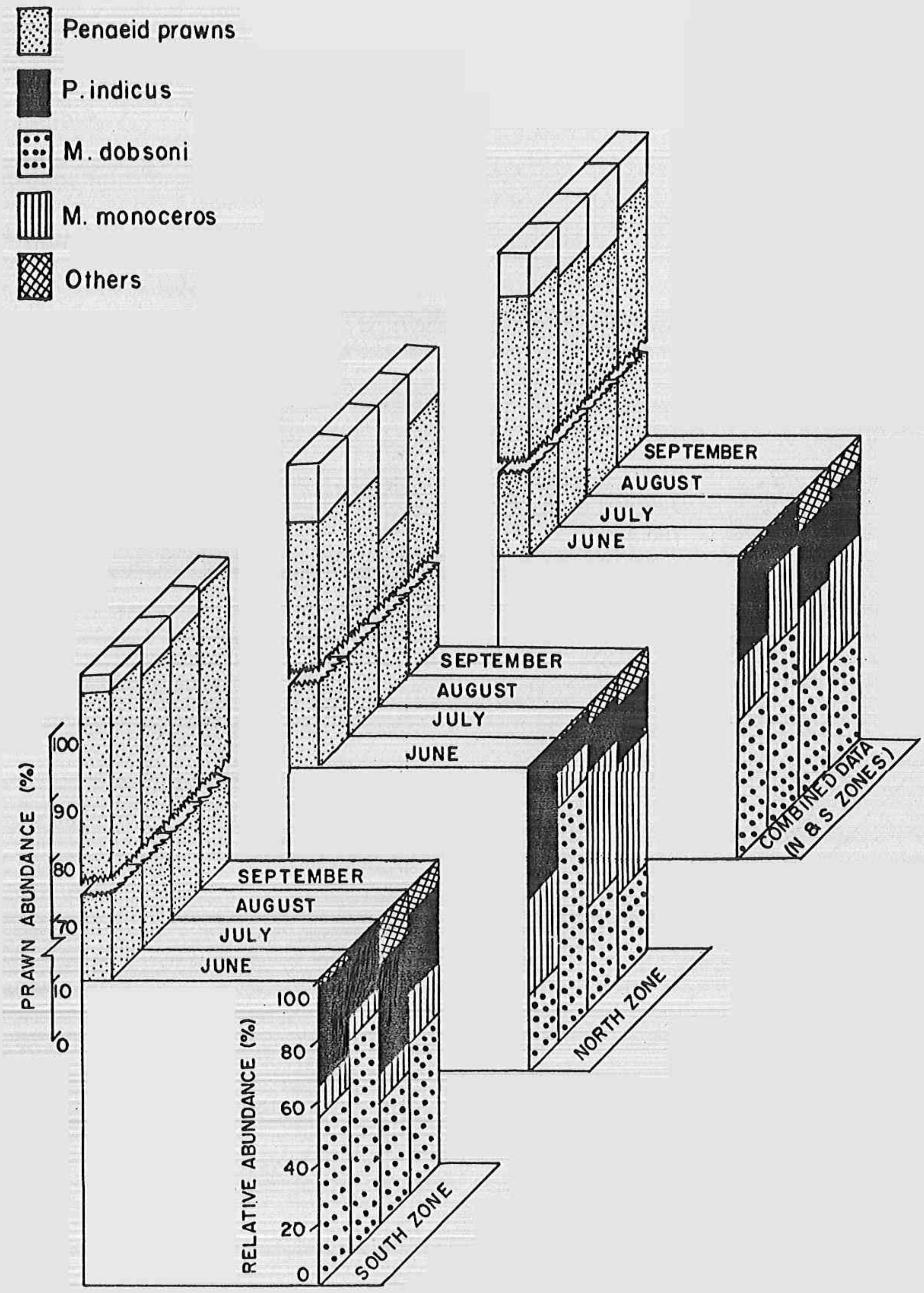
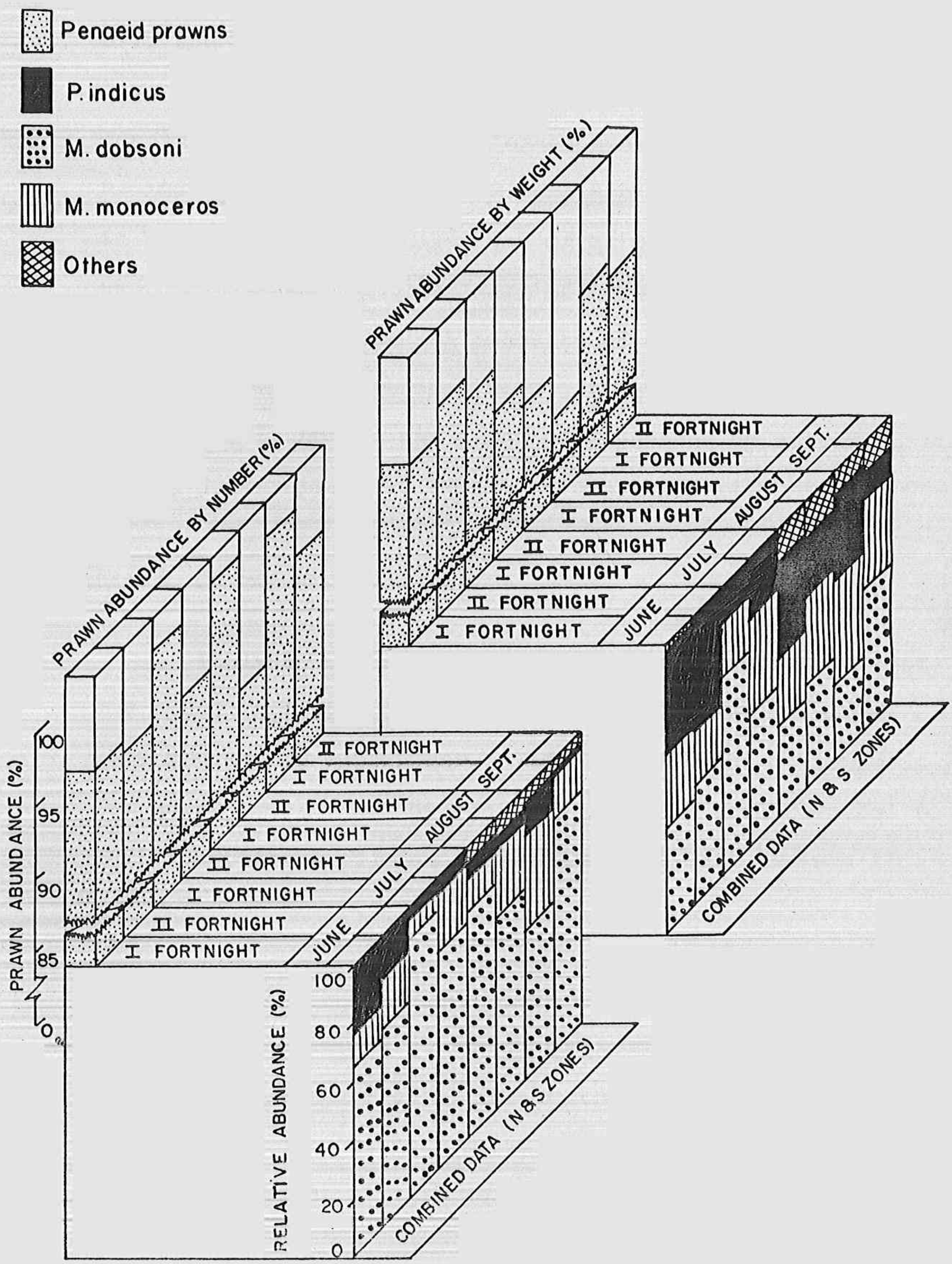


Fig. 13
FORTNIGHTLY TREATMENT - CONSOLIDATED DATA (N & S ZONES)
(PRAWN ABUNDANCE BY NUMBER AND WEIGHT)



P. indicus contributed nearly 6.3 and 14.3%, M. dobsoni 67.6 and 74.0%, M. monoceros 24.3 and 7.5% and M. affinis 1.8 and 4.2% at north and south zones (stations 3 and 1) respectively. The data indicated that juveniles of P. indicus, M. dobsoni and M. affinis were relatively more in the south zone; while that of M. monoceros was more in the north zone. Combined data of north and south zones indicated that M. dobsoni constituted the maximum of 70.8% followed by M. monoceros (15.9%), P. indicus (10.3%) and M. affinis (3.0%) in the order of abundance by number during June-September. (Table 7; Fig. 10 & 11).

5.2.2 Abundance by weight

Analysis of the prawn data by weight indicated that the percentage of penaeid prawns was about 86% in north zone and 97% in south zone. The overall value of penaeids for north zone by weight was less (86.31%) when compared to their percentage abundance by number (94.56%) as seen from Table 7.

By weight, M. dobsoni represented 34.1 and 52.0%, M. monoceros 42.6 and 13.2%, P. indicus 20.7 and 29.3% and M. affinis 2.6 and 5.6% at the north and south zones respectively. The data analysis by weight indicated that P. indicus, M. dobsoni and M. affinis were relatively abundant in south zone; and that of M. monoceros was more in north zone as in the case of analysis by number. (Table 7). However, combined data of north and south zones to represent the ecosystem in general, revealed that M. dobsoni constituted the maximum (43.0%), followed by M. monoceros (27.9%), P. indicus (25.0%) and M. affinis (4.1%) for the study area in the same order of abundance as in the case of analysis by number (Table 7 and Figs. 12 & 13).

6. QUANTITATIVE ESTIMATION

Quantitative estimation of penaeid prawn seeds and juveniles were attempted based on the quantitative data collected on seeds from the shallow areas of less than one metre depth and on the juveniles by the analysis of prawn fishery samples obtained from local landing centres of north and south zones.

6.1 Estimation of penaeid prawn seed resources

Two gears viz. velon screen Drag net (VN) and Experimental Drag net (DN) were used for the collection of prawn seeds. To study the catch efficiency of these two gears, fortnightly seed data collected during June-September from the three stations (observation centres) were treated and tested gear-wise. The values obtained by experimental

Table 8. Gear-wise monthly average data* on penaeid prawn seed abundance and catch efficiency (Number per 10 m^2)

	June	July	August	Sept-ember	June-September (Average)
Velon Screen Drag Net (VN)	72	64	96	24	64
Experimental Drag Net (DN)**	64	80	128	16	72
Average of VN & DN	68	72	112	20	68

* Pooled up average data of North, Middle and South Zones (average of 6 values each)

** Actual values (per 2 m^2) - raised to 10 m^2

Table 9. Quantitative estimation of penaeid prawn seeds*
(Number per 100 m^2)**

	June			July			August			September			Season's Average (June-Sept.)			Average of NZ + MZ + SZ
	NZ	MZ	SZ	NZ	MZ	SZ	NZ	MZ	SZ	NZ	MZ	SZ	NZ	MZ	SZ	
P. indicus	12	4	376	8	8	32	4	16	48	4	8	32	16	8	124	48
M. dobsoni	1216	312	108	916	372	784	1980	408	816	116	52	300	1048	288	500	616
M. monoceros	--	--	--	4	4	--	80	24	32	8	4	44	24	8	20	16
Total penaeids	1228	316	484	928	384	816	2064	448	896	128	64	376	1088	304	644	680

* Figures rounded off to the nearest number

** Gear employed: VN & DN

Drag net (DN) per two square metres were raised to 10 m^2 to compare the data with velon screen catches (Table 8). As there was no significant difference in the catches of these two gears were utilized for the quantitative estimation of penaeid prawn resources.

During the present study, peak period of occurrence of penaeid prawn seeds were observed during August and a secondary peak in June from all the three zones, dominated mostly by M. dobsoni. The quantitative data collected by Velon screen drag-net and Experimental drag-net were extrapolated to 100 m^2 area and the estimated values are given in Table 9 for the three zones.

The data indicated that P. indicus seeds were generally less during this period. However, a small peak was observed during June in the south zone; and were poor in September. In general, P. indicus seeds were comparatively more in the south zone than from north and middle zones. M. dobsoni seeds were abundant throughout the period. The peak period of abundance was found to be in August and were more in north zone than the other zones (Table 9).

Similarly M. monoceros seeds, though of lesser magnitude, also projected an indication of abundance during

Table 10. Quantitative Estimation of juvenile Penaeid Prawn Landings

Period		North Zone			South Zone		
	Estimated total* Catch (P&NP) (Kg)	Estimated catch* of penaeids (Kg)	Penaeids c/u (Kg)	Estimated catch (P&NP) (Kg)	Estimated catch of Penaeids (Kg)	Penaeids c/u (Kg)	Local rain-fall (mm)
Fortnightly							
June I	350	312	4.050	534	521	2.430	234
II	3C3	284	3.120	816	796	3.400	361
July I	950	890	5.930	1235	1146	4.410	250
II	532	451	4.960	1374	1356	4.710	42
Aug. I	642	479	4.560	2157	2107	6.690	122
II	1062	850	6.070	1624	1497	5.090	481
Sept. I	1260	1114	6.630	1755	1735	6.670	10
II	1104	954	6.200	2886	2846	8.750	100
Month-wise							
June	653	596	3.530	1350	1317	2.940	595
July	1482	1341	5.580	2609	2502	4.560	292
Aug.	1704	1329	5.380	3781	3604	5.890	603
Sept.	2364	2068	6.420	4641	4581	7.830	110
Seasonal							
June-Sept.	6203	5334 (86%)	5.420	12381	12004 (97%)	5.470	1600

*-Catch figures rounded off to nearest Kg
c/u - Catch per canoe in Kg
P & NP - Penaeids and Non-penaeids

August especially in the north zone when compared to other months; and were totally absent during June. Seeds of M. affinis were exclusively absent during the season in the shallow estuarine waters of Cochin. Zone-wise data indicated that north zone had the maximum seed availability.

The penaeid prawn seed resource potential of the surveyed ecosystem was estimated as 680 Nos. with their monthly fluctuations as 675, 710, 1135 and 190 Nos. per 100 m^2 and that of P. indicus, M. dobsoni and M. monoceros was estimated as 48, 616 and 16 Nos. per 100 m^2 during south-west monsoon season in 1987. The average resource potential for the north, middle and south zones were estimated as 1088, 304 and 644 seeds per 100 m^2 respectively.

6.2 Estimation of penaeid juvenile resources

Quantitative estimation of the penaeid prawn fishery, comprising of juveniles, was made based on the weekly catch data collected from the local landing centres of north and south zones in the ecosystem during June-September. During this monsoon period, prawn landings exceeded fish landing in the Cochin backwater. A progressive increase in the total prawn landings as well as in the catch per unit (c/u) were noticed at both north and south zones (Table 10). Catch per unit (canoe) increased from 3.530 to 6.420 kgs in the

Table 11. Consolidated diurnal data on hydrography and prawn seed abundance for the season (Average of monthly diurnal data during June-September)

Hours	Tidal Amplitude (cm)	Water Temp. (°C)	Salinity (‰)	Dissolved oxygen (ml/L)	Number of Penaeid seeds per 100 m^2				
					Total prawns (P+NP)	Total penaeids	*P. indicus*	*M. dobsoni*	*M. monoceros*
					North Zone				
0600	13	28.25	0.24	3.31	1412	1358	8	1318	32
0800	12	29.60	0.24	4.47	1212	1093	4	1073	16
1000	25	31.25	0.38	5.38	1210	1109	6	1063	40
1200	38	31.60	0.64	5.58	1704	1613	17	1569	27
1400	47	31.85	0.76	5.53	1010	952	4	913	35
1600	36	31.80	1.01	5.53	815	771	4	744	23
1800	22	31.60	0.93	5.54	783	721	2	707	12
Ave.	28	30.85	0.60	5.05	1164	1088 93.5%	6	1055	26
					South Zone				
0600	12	28.65	1.63	3.62	837	523	54	469	--
0800	19	29.05	0.96	3.83	1469	1319	54	1238	27
1000	49	30.20	1.66	3.84	866	660	412	221	27
1200	53	30.95	2.15	4.32	644	467	110	357	--
1400	51	30.35	4.03	4.44	554	358	54	250	54
1600	33	30.45	4.20	4.46	598	550	83	467	--
1800	19	30.50	3.98	4.29	724	631	83	521	27
Ave.	34	30.02	2.66	4.11	813	644 79.2%	121	503	19

Table 11*a*. <u>Relative productive potential of penaeid prawn seeds and juveniles in Cochin backwater</u>

SOUTH ZONE					ERNAKULAM CHANNEL IN COCHIN BACKWATER	NORTH ZONE				
P.in (in percentage)	M.dob (in percentage)	M.mon (in percentage)	M.aff (in percentage)	12381 Kgs.	Estimated total prawn catch (P+NP) 18584 Kgs.	6203 Kgs	P.in (in percentage)	M.dob (in percentage)	M.mon (in percentage)	M.aff (in percentage)
29.27	51.96	13.20	5.57	96.76% (12004 Kgs)	Fishery catch data Random samples Juveniles + pre-adults (by weight) 91.54%	86.31% (5334 Kgs.)	20.73	34.05	42.61	2.61
14.30	73.98	7.52	4.20	94.74%	Fishery catch data Random samples Juveniles + pre-adults (by number) 94.65%	94.56%	6.32	67.58	24.28	1.82
18.79	78.16	2.95	--	79.20% (644 Nos/ 100 m^2)	Seed data Early juveniles (by number) 86.35%	93.50% (1088 Nos/100 m^2)	0.55	96.96	2.39	--
6.67	80.0	13.33	--	100%	Postlarvae 100% (by number)	100%	5.56	83.33	11.11	--

Fig. 14

PHYSICO-CHEMICAL FACTORS IN RELATION TO PRAWN ABUNDANCE

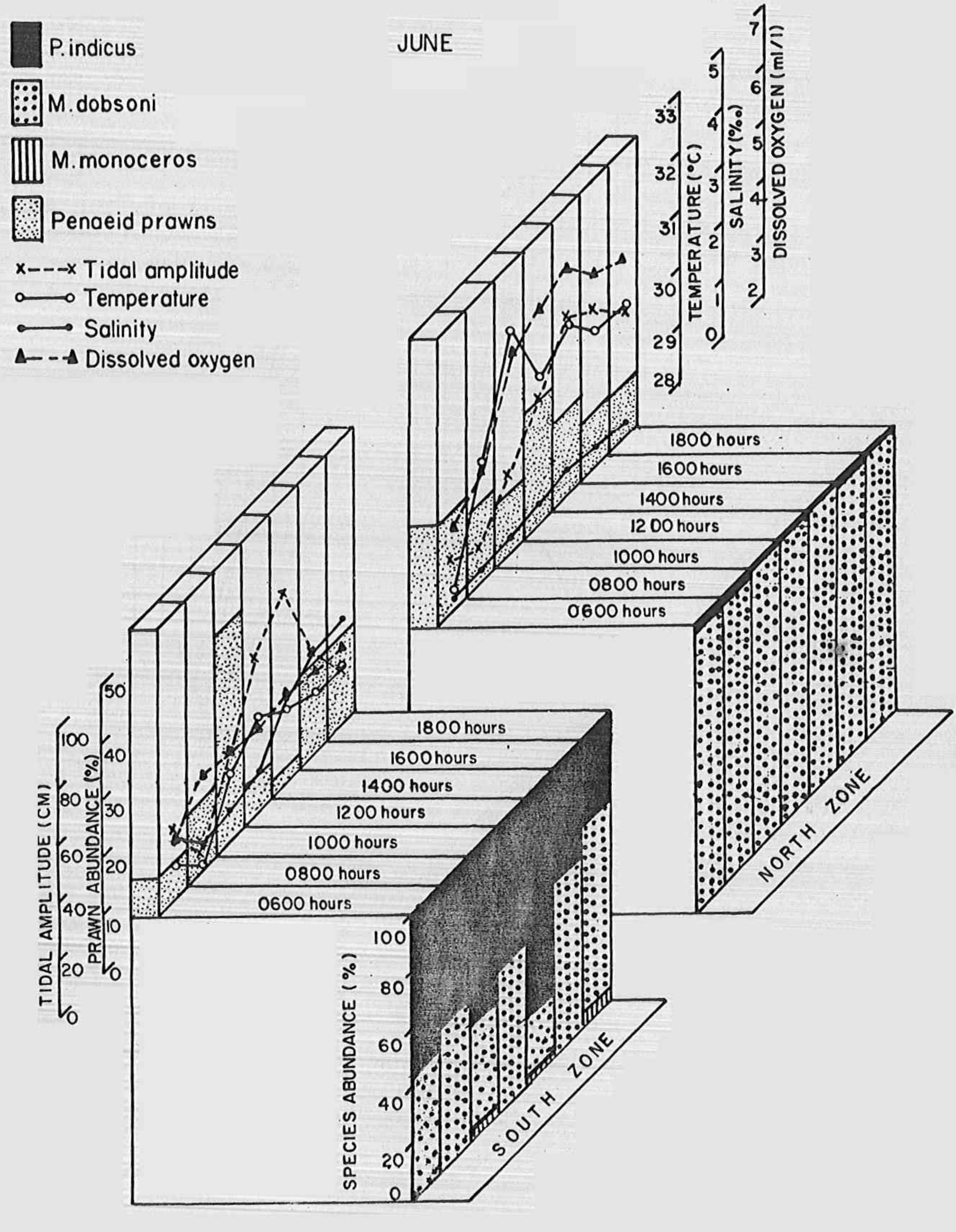


Fig. 15

PHYSICO-CHEMICAL FACTORS IN RELATION TO PRAWN ABUNDANCE

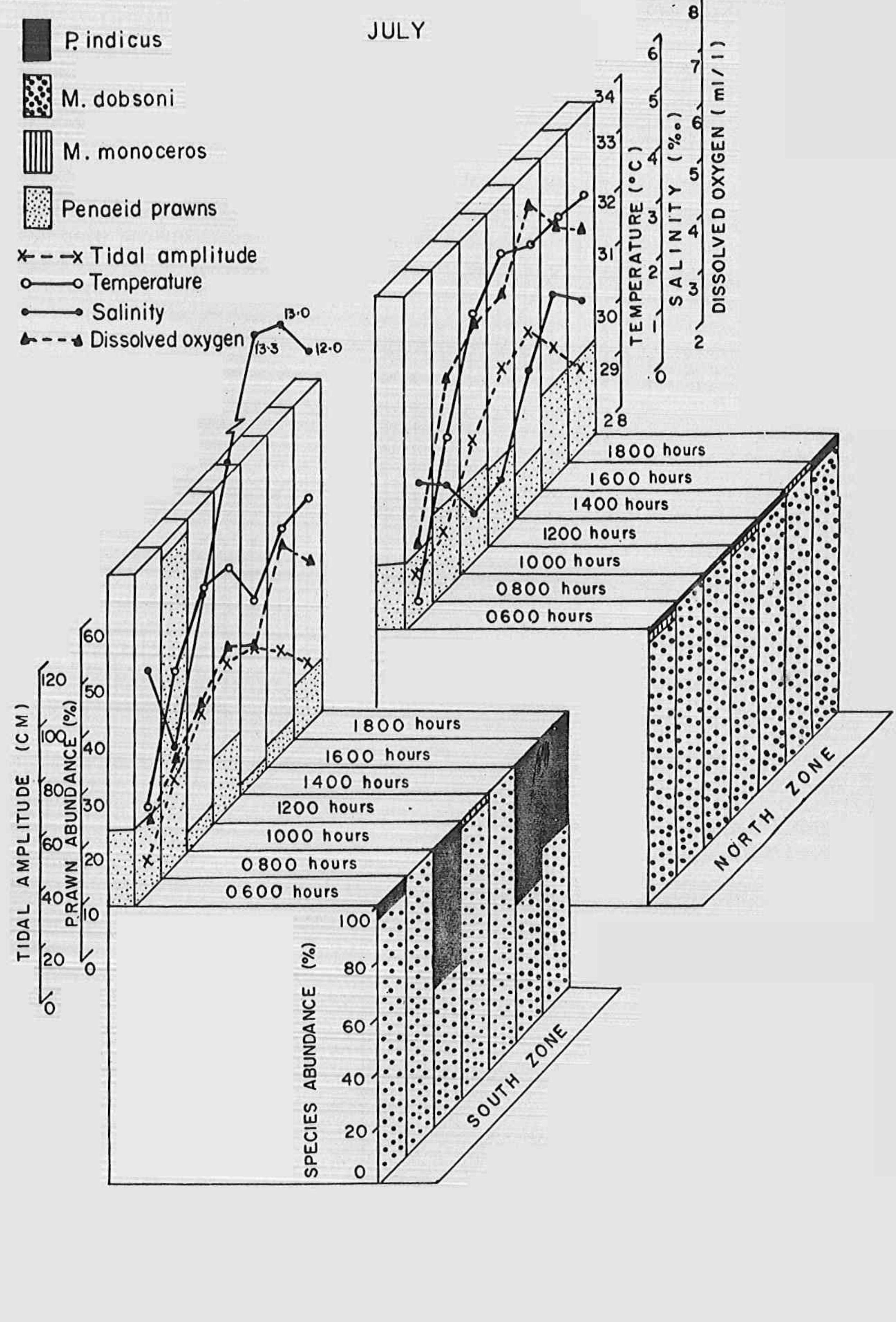


Fig.16

PHYSICO-CHEMICAL FACTORS IN RELATION TO PRAWN ABUNDANCE

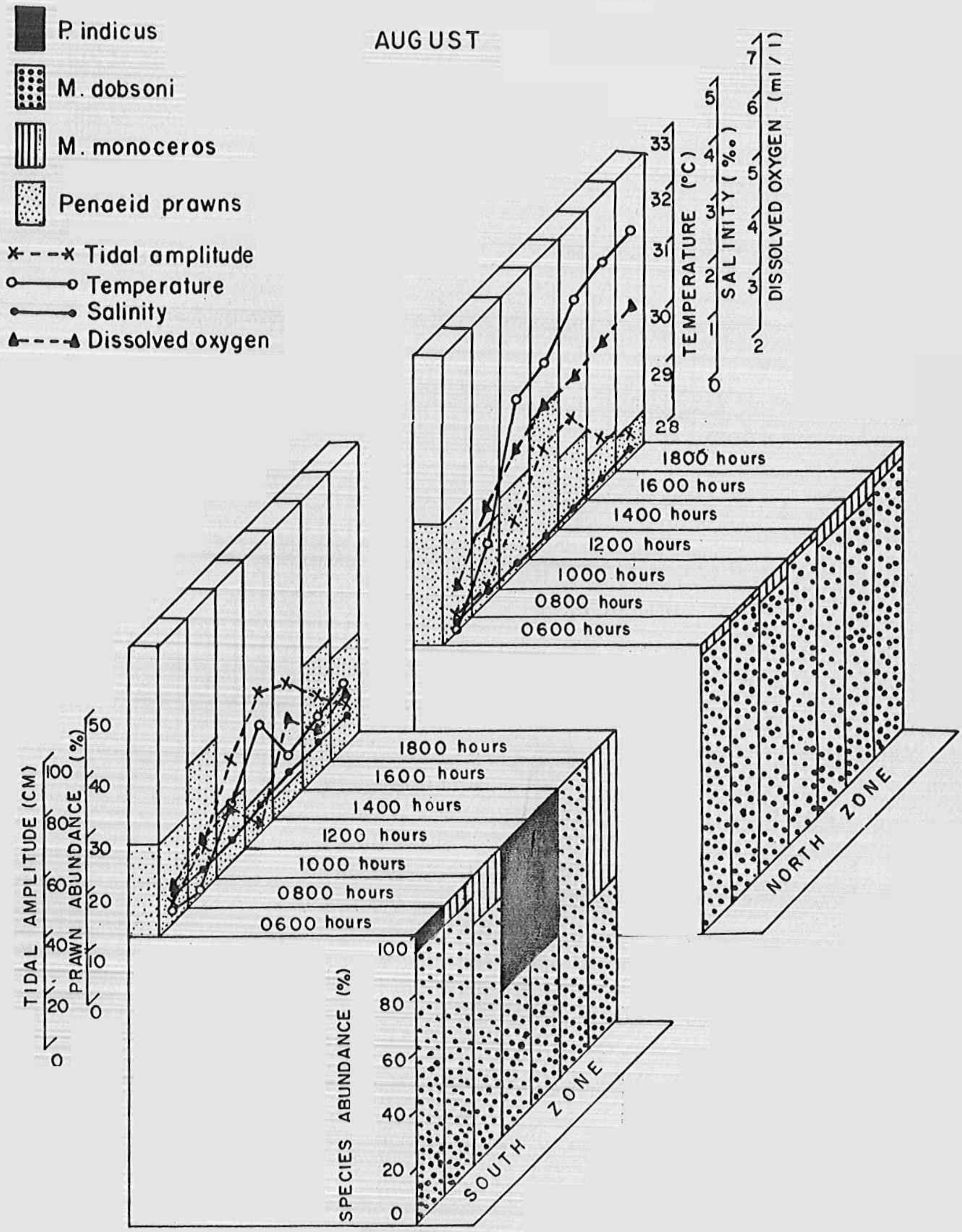


Fig. 17

PHYSICO-CHEMICAL FACTORS IN RELATION TO PRAWN ABUNDANCE

SEPTEMBER

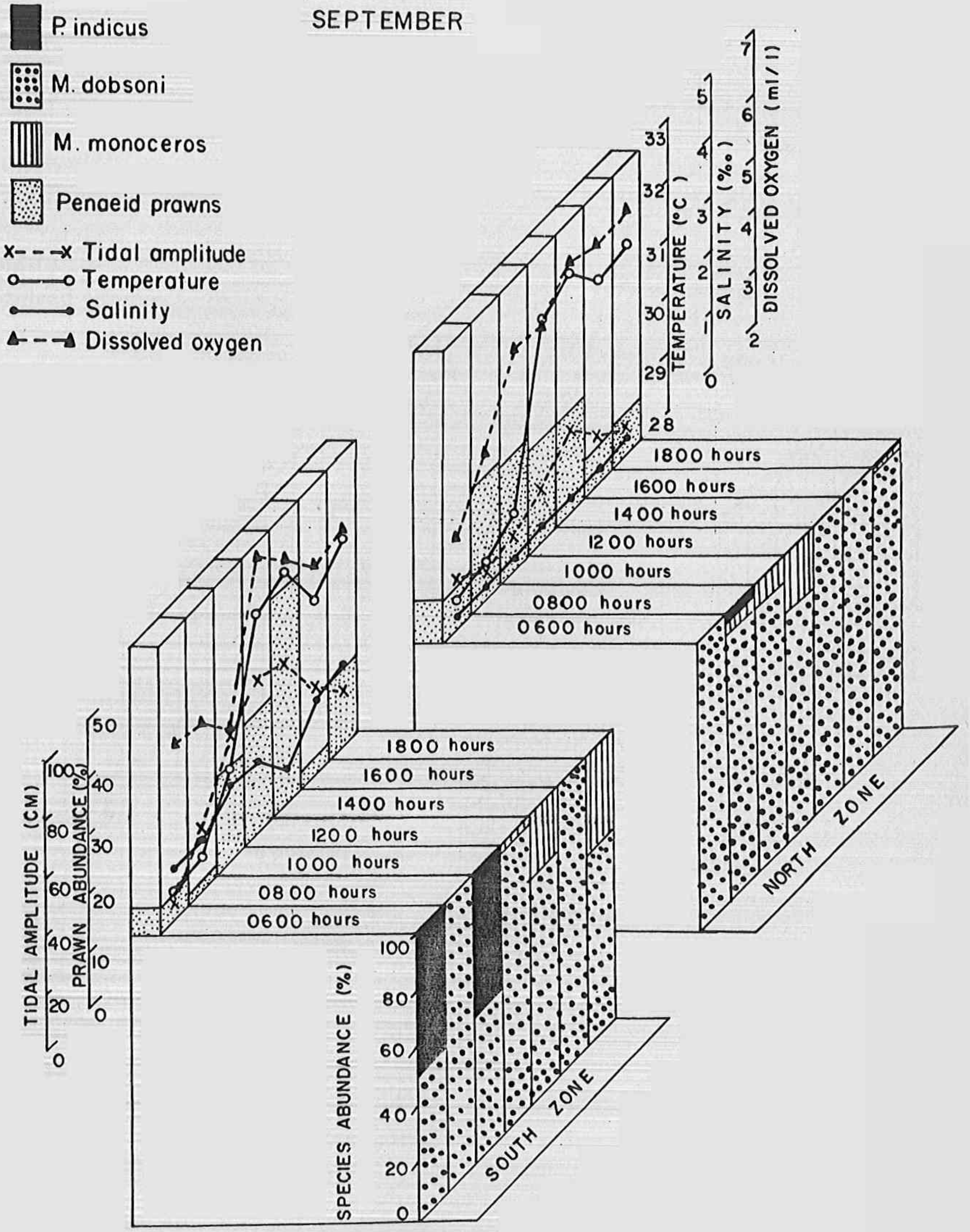
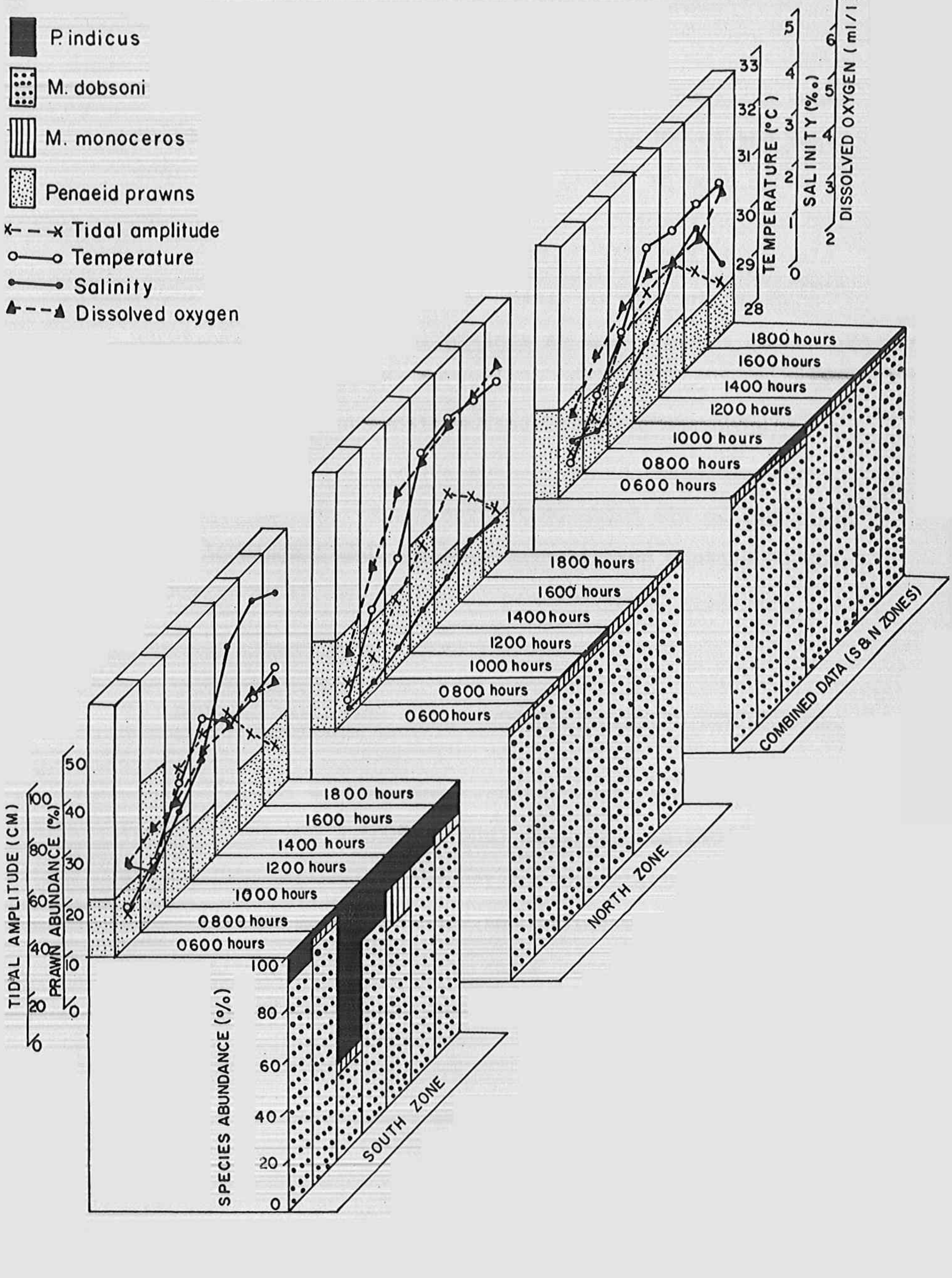


Fig.18

DIURNAL OBSERVATIONS (JUNE-SEPTEMBER) - CONSOLIDATED DATA



north zone and from 2.940 to 7.830 kgs in the south zone. Landings in September contributed nearly 38% of the total monsoon catch of juvenile penaeid prawns in both zones.

An estimated total landing of 5334 kgs of penaeid prawn juveniles constituting mainly M. dobsoni, M. monoceros, P. indicus and M. affinis in the order of abundance were obtained from the north zone which formed about 86% of the total prawn landings (including non-penaeids); whereas in the south zone, the estimated penaeid prawn catch was 12,004 kgs constituting about 97% of the total prawn landings (Table 10). A consolidated picture of the ecosystem on the abundance of penaeid prawn seeds and juveniles is given in Table 11a.

7. DIURNAL INFLUENCE OF HYDROGRAPHY ON PRAWN SEED ABUNDANCE

Monthly diurnal observations were made at station 1 (south zone) and 3 (north zone) from 0600 to 1800 hours during June-September to study the correlation between penaeid prawn seed abundance and ecological parameters such as tide, time of collection, water temperature, salinity and dissolved oxygen and the results are illustrated in Table 11 and Figs. 14-18.

Table 12. Penaeid prawn seed abundance in relation to tides
(Percentage abundance in number)

Month	P. indicus		M. dobsoni		M. monoceros		Tot. penaeids	
	L.T	H.T	L.T	H.T	L.T	H.T	L.T	H.T
June	38.89	61.11	37.56	62.44	20.00	80.00	37.17	62.83
July	37.05	62.05	45.34	54.66	64.29	35.71	47.25	52.75
August	20.00	80.00	34.62	65.38	38.57	61.43	34.06	65.94
Sept.	40.00	60.00	26.96	73.04	61.11	38.89	21.07	78.30
June - Sept.	33.96	66.04	37.59	62.41	44.34	55.66	37.31	62.89

L.T = Low tide

H.T = High tide

Table 13. Penaeid prawn seed abundance in relation to time

(Percentage abundance in number)

Month	*P. indicus* FN	*P. indicus* AN	*M. dobsoni* FN	*M. dobsoni* AN	*M. monoceros* FN	*M. monoceros* AN	Tot. penaeids FN	Tot. penaeids AN
June	77.14	22.86	64.78	35.22	50.00	50.00	65.13	34.87
July	87.05	12.05	57.59	42.41	42.86	57.14	57.98	42.02
Aug.	33.33	66.67	75.17	24.83	63.64	36.36	74.27	25.73
Sept.	75.00	25.00	63.48	36.52	70.00	30.00	63.85	36.15
June-Sept.	73.58	26.42	63.48	36.52	64.15	35.85	67.82	32.18

FN: Forenoon AN: Afternoon

7.1 Tides in relation to seed abundance

Tides in Cochin backwater were mixed semidiurnal type with substantial difference in range and time. The results showed that the average tidal amplitude was lesser in north zone than in south zone in all months. Present study revealed that seeds of P. indicus, M. dobsoni M. monoceros and total penaeids in general, were abundant at high tide during monsoon season (Table 12).

7.2 Time of collection in relation to seed abundance

An attempt was made to correlate the seed abundance with time and the study indicated that seeds of P. indicus, M. dobsoni, M. monoceros and total penaeids in general, were abundant in the catch during forenoon rather than afternoon (Table 13).

7.3 Hydrographic parameters in relation to seed abundance

7.3.1 Water temperature

Water temperature in the shallow waters was generally low in the morning and marginal increase was noticed in the afternoon hours. On an average, north zone exhibited higher water temperature than south zone. The data indicated that prawn seeds (P + NP) were abundant in the morning hours when the temperature was low at 0600-0800 hours in the north and south zones (Table 11).

7.3.2 Salinity

Salinity in shallow waters was remarkably higher in the south zone. During June-September, higher salinity values were recorded in both zones two hours after the highest tide, i.e. during low tidal flow, when the tide level was medium, as evidenced by the tidal height and the average peak values being 1.01‰ in north zone and 4.2‰ in south zone (Table 11). The data indicated that while M. dobsoni seeds were abundant in the low saline areas (north zone) seeds of P. indicus were comparatively more in the higher saline areas (south zone) during this season.

7.3.3 Dissolved oxygen

Low values of dissolved oxygen content (3.31 and 3.62 ml/l on an average for north zone and south zone respectively) were recorded in the morning hours and it gradually increased to 5.58 and 4.46 ml/l (average values) in the afternoon for north and south zones respectively. Dissolved oxygen values were, in general, higher in the north zone and

Table 14. Correlation coefficients of Penaeid prawn seeds in relation to hydrographic parameters

	P. indicus	*M. dobsoni*	*M. monoceros*	Total penaeids
		NORTH ZONE		
Tidal Amplitude	0.2087	-0.0904	0.3357	-0.074
Temperature	-0.032	-0.3961	-0.0130	-0.3867
Salinity	-0.2096	-0.587	-0.3092	-0.585
Dissolved oxygen	-0.0141	-0.3640	-0.0661	-0.3569
		SOUTH ZONE		
Total Amplitude	0.4463	-0.6096	0.2594	-0.4629
Temperature	0.2172	-0.5476	0.0899	-0.4995
Salinity	-0.285	-0.4390	0.2206	-0.5831
Dissolved oxygen	-0.2691	-0.336	0.1735	-0.4673

this was reflected in the abundance of penaeid prawn seeds in the north zone during south west monsoon season (Table 11).

To understand whether hydrographic parameters like tidal amplitude, temperature, salinity, dissolved oxygen have any effect on the different penaeid species and penaeids in general, correlation analysis was attempted and the results are given in Table 14.

DISCUSSION

The Cochin Backwater System is profoundly influenced by the monsoons, especially the southwest monsoon and receives an average annual rainfall of 323 cm (Daily Weather Chart). Consequently there is considerable influx of nutrient-rich fresh water, which when penetrated by the tidal sea currents, results in a highly dynamic environment.

On the basis of the monsoon effects and associated climatic changes, three seasons are recognised in a year along the southwest coast of India; viz. the stable pre-monsoon (February-May), the unstable monsoon season (June-September), and the relatively less stable postmonsoon season (October-January). Although the above course of events follows a cyclic pattern, wide fluctuations in the hydrographic and biological features have been observed in Cochin Backwater within the monsoon season itself. The topographic features of the backwater system, tidal currents and water circulation are the master factors which play important role in making these estuarine waters a highly complex environment. The bottom topography such as slope and elevation from mean sea level governs the tidal currents and tidal amplitude and thereby influences the water circulation in the backwater. The water circulation pattern, in turn, governs the factors like distribution of temperature, salinity, dissolved oxygen and other chemical components of water which control the distribution of organisms present in the ecosystem.

As regards the annual rainfall of Kerala (323 cm), more than 75% of the rainfall is recorded during southwest monsoon period (Silas and Pillai, 1975). The rainfall data obtained in the present study during the southwest monsoon season for Cochin (160 cm) clearly indicates the failure of southwest monsoon around Cochin region during 1987.

Although the water temperature did not show much variation among the three stations, the relatively higher temperature recorded in the north zone (station-3) might be due to the shallowness of the water body and partly due to less tidal influence as evidenced from the salinity values (Table-1). The low water temperature recorded in the morning hours (Table-11) might be due to the influence of atmospheric temperature prevailed at night during the monsoon season.

Tidal amplitude and salinity are closely related parameters influenced by tidal currents. The relatively low tidal amplitude recorded at north zone (Figs. 14-18; Table-11) may be due to the mixed semi-diurnal nature of tides with substantial difference in range and time and partly by the less tidal influence due to the elevation and slope of bottom topography. The high salinity values recorded at middle and south zones (Table-1) indicate high tidal influence and this may be related to depth, slope, volume of waterbody, high tidal amplitude and water circulation in the south zone (station-1) and, in addition, the nearness to barmouth in the case of middle zone (station-2). The low salinity values recorded in highest tide of the day may be attributed to the Hydrodynamics of the estuarine ecosystem during monsoon season. Silas and Pillai (1975) have stated that "the reversal of tidal current at the surface lags behind the tidal height by about two hours". It is more likely that it may be related to the circulatory pattern of the ecosystem occurring during high and low tides.

The low values of dissolved oxygen obtained in the morning hours of diurnal observations and the gradual increase during the day time at north and south zones (Table-11) may be related to the community metabolism such as respiratory activities of organisms during night hours and the photosynthetic activity during day time respectively. The higher oxygen values (> 6.00 ml/L) obtained in the present study might be due to the high photosynthetic productivity of the ecosystem during southwest monsoon season. Mohamed and Rao (1971) have also recorded such higher values (7.92 ml/L) during southwest monsoon season from the Cochin Backwater. The relatively higher oxygen values obtained at north zone suggest that this zone is highly productive than the south and middle zones; and the diurnal increase in oxygen values shows direct relationship with surface water temperature during monsoon season (Figs. 14-18).

Representation of more species in good quantity at a particular area indicates the productive potential of the area. The average penaeid prawn seed resource potential of south, middle and north zones estimated as 644, 304 and 1088 seeds per 100 m^2 respectively, also indicates that north zone is highly productive followed by south and then middle zone (Table-9).

The recruitment of postlarvae and the occurrence of seeds in the estuarine ecosystem gives an indication on the spawning intensity of the respective species in space and time and detection of spawning season would help in hatchery operations for obtaining the wild spawners of cultivable species from the inshore waters of the sea. Although different species of penaeid prawns occur in the ecosystem, their peaks of abundance vary with species to species, zone to zone and within the species concerned in different months during the southwest monsoon season.

The abundance of penaeid seeds of _M. dobsoni_, _P. indicus_ and _M. monoceros_ observed during this season is comparable to the average percentage recorded by Kuttyamma (1975) and Suseelan and Kathirvel (1982). The abundance of juveniles also follows almost the same trend in the abundance of dominant species of M. dobsoni; while P. indicus and M. monoceros show remarkable fluctuations in abundance between north and south zones and M. affinis the least among these four species. This is in close agreement with the works of Menon and Raman (1961), George (1975), Kuttyamma and Antony (1975), and Paulinose et al. (1981).

The size range of seeds of P. indicus, M. dobsoni and M. monoceros reported in the present study are comparable with the results of Suseelan and Kathirvel (1982). The scarcity of postlarvae and absence of 6-15 mm size groups in P. indicus at north and south zones indicate that the spawning season of this species does not in any way fall within monsoon season. However, the availability of 16-20 mm size group at both zones in lesser magnitude indicates minor recruitment in the backwater during this season and the seeds were relatively more in June with an average of 48 Nos./100 m^2 for the season (Table-9). The percentage abundance of M. dobsoni seeds reveals continuous recruitment of the species with an average of 616 Nos./100 m^2 having peaks in June and August and the least in September. The abundance of indeterminates during June-September especially at north zone indicates the continuous recruitment, the high intensity of spawning and the congenial condition of the ecosystem, especially the north zone of Cochin Backwater. The presence of early juveniles of M. monoceros during July-September represented by few numbers with an average of 16 Nos./100 m^2 for the ecosystem suggests a relatively minor recruitment during this season (Table-9).

The absence of seeds of M. affinis in the shallow waters of less than one metre reported herein, may be referred to the observations made by Suseelan and Kathirvel (1982). They have reported based on velon screen and try-net collections that M. affinis prefer deeper areas in the estuary. But, the non-availability of their juveniles and preadults in the shallow and deeper areas during June and July, and poor representation in August-September, as evidenced from the seed collection and commercial prawn catch data of north and south zones in the backwater, (Table-9 and Fig. 7) indicate that the recruitment of this species is not continuous and this species may have a definite spawning season which does not fall during June-September (southwest monsoon season).

It is interesting to note that the penaeid prawns collected from the shallow areas of less than one metre depth by velon screen and Drag net did not encounter any larger sized juveniles beyond 45 mm size, while the fishery samples obtained simultaneously from further deeper areas of the backwater constituted larger size groups. The absence of larger-sized juveniles in the shallow area confirms their movement into the deeper areas of the estuary. This may be attributed to their physiological requirement of higher saline media coupled with other water characteristics of the environment. It is presumed that once they get accustomed to the deeper high saline environment and attain late juvenile or preadult stage, they emigrate to the sea through the deeper layers, or even earlier, especially during the southwest monsoon months (due to the unstable environment) as evidenced by the presence of smaller size groups in the marine trawl catches. Mohamed and Rao (1971) have related this seaward movement of prawns to sexual instinct.

The present study further indicates that larger sized juveniles of P. indicus, M. dobsoni, M. monoceros and M. affinis of size beyond 120, 65, 85 and 80 mm are less in percentage and their maximum size recorded during the present investigation are 132, 90, 110 and 100 mm (preadult stage) respectively, which fall within the range, as reported by earlier workers [Menon and Raman (1961), George (1975), Kuttyamma and Antony (1975), Paulinose et al (1981)]. It has been reported that females of P. indicus, M. dobsoni and

M. affinis attain first maturity when they attain 130.2, 64.1 and 88.6 mm and males at 102, 53.6 and 71.6 mm respectively (Rao 1968, 1978) and females and males of M. monoceros at 82 and 74.0 mm (George and Rao, 1968; Rao, 1978). Kuttyamma and Antony (1975) have recorded P. indicus of size upto 140 mm in Cochin Backwater. Since mature specimens are generally absent in the estuaries, and as their spawning (in nature) is so far recorded only from the sea, it is obvious that their seaward movement (emigration) is activated greatly by sexual instinct under normal condition when the estuarine features are favourable for their growth to attain the preadult stage. The low percentage of larger size groups of these species in the Cochin estuarine system may be related to emigration, although fishing has its role within the estuarine ecosystem.

Representation of all size groups in fairly good number at a particular zone indicates seggregation of the species as observed in the case of M. dobsoni at both zones and M. monoceros at north zone (Figs. 5 & 6). The uneven distribution observed in the present investigation by the absence or reduction of certain intermediate size groups in P. indicus and M. affinis at both zones, especially the south zone and of M. monoceros at south zone (Figs. 4, 6 and 7) particularly during the later half of the southwest monsoon (August-September) may be related to fishery exploitation in the backwater, as observed from the increase in prawn catch data at north and south zones (3397 and 8185 kgs) which contributed about 63.7 and 68.2% of the total monsoon catch obtained during June-September (Table-10). The sudden occurrence of size groups which were absent in the previous fortnight or month as observed in the case of P. indicus and M. affinis (Fig. 4 & 7) may be related to the movement of the species into these north and south zones from the northern and southern upper reaches of the backwater system respectively due to the alteration of the environment by heavy influx of fresh water as a result of southwest monsoon. The progressive increase in the prawn catch noticed from June to September at these zones (Table-10) is a clear evidence of their movement towards Cochin barmouth, where fairly good saline condition prevails during the monsoon season. The less species diversity observed during this season may be due to the unstable environment.

A perusal of literature on the sex ratio of penaeid prawns from the backwater and marine environment reveals that the sex ratio of prawns vary in space and time. In the case of P. indicus, (Menon, 1957) has reported that females were generally larger in size than males in the inshore waters off Cochin; George et al. (1963) have observed the dominance of males in the offshore fishery of Cochin. From Cochin Backwater, Kuttyamma and Antony (1975) have reported the dominance of males while Paulinose *et al*. (1981) have observed the dominance of female population in the perennial ponds adjacent to Cochin Backwater. Menon (1957) has related the difference in the representation of sexes in *M. dobsoni* to migration; George and Rao (1967) have concluded that the differential sex-ratios of *M. dobsoni* may be the result of breeding migration of females; and the same has been supported later by Kuttyamma and Antony (1975). But, the present study clearly shows that males and females of *P. indicus* and *M. dobsoni* are distributed in almost same size range in the ecosystem (Fig. 9) and thereby rules out the process of emigration of one sex earlier.

In the case of *M. monoceros*, George (1959) has observed that females were slightly higher than males in the Cochin backwater during 1952-55, the values being 50.76, 51.08 and 51.31% in each year. Later, Kuttyamma and Antony (1975) and Paulinose *et al*. (1981) have added support to this finding. The present study confirms the dominance of females in the population of *P. indicus*, *M. dobsoni* and *M. monoceros* and males in the case of *M. affinis*.

The present study concludes that the sex-ratio of penaeid prawns in the Cochin Backwater may vary from year to year and season to season and it is not generally related to emigration. Sex-ratio may vary with each recruitment and it would be reflected in the different stock of same species. As various stockspresent in the environment, as a result of frequent recruitment, are likely to get mixed up or get away from an affected area due to environmental changes and stress, the sex ratio may vary from zone to zone as observed in the case of P. indicus, M. monoceros and M. affinis at north and south zones (Table 6 & Fig. 8). Occurrence of more indeterminates in the case of M. dobsoni may be due to the intensive recruitment of the species during this season.

The average penaeid prawn seed resource potential of the entire surveyed ecosystem has been estimated as 680 Nos./100 m^2 with monthly fluctuations of 675, 710, 1135 and 190 Nos./100 m^2 during June-September. The estimated numbers for P. indicus, M. dobsoni and M. monoceros are about 48, 616 and 16 Nos./100 m^2 during the southwest monsoon season.

The estimated penaeid prawn juvenile catch of 5334 kgs and 12004 kgs from the north and south zones indicate the fishery potential of the respective zones; which constitute to 94.65% by number and 91.54% by weight among the total crustacean landings and the species composition on average (by number and weight) being M. dobsoni (70.8:43.0), M. monoceros (15.9:27.9), P. indicus (10.3:25.0) and M. affinis (3.0:4.1) in percentage respectively in the order of abundance for the ecosystem in general during southwest monsoon season.

The estimated catch for south zone (12004 kgs), when compared with the similar catch data of 1957 for the same centre (Thevara) reported by Menon and Raman (1961), shows about three-fold increase in catch during 1957-1987. The increase in catch during this year may be mainly due to the intermittant break of rainfall and occasional light showers (George, 1959) occurred around this ecosystem during June-September; and partly due to the increasing efforts and by the prolonged impact of Thanneermukkom bund.

The abundance of juveniles in the fishery of the ecosystem studied in relation to number and weight is comparable with the findings of Menon and Raman (1961) based on the data for 1957 and 1958. Since then, there is hardly any such information available from this estuarine system. The relation between number and weight of penaeids indicates that the weight increases in % for P. indicus, M. monoceros and M. affinis and decreases for M. dobsoni and is related to weight of exoskeleton of the species concerned.

The present observations on penaeid prawn seed and juvenile abundance and distribution in relation to their number and weight during the southwest monsoon season

(Table-11a) should be of some use for judicious exploitation of the resources in the ecosystem.

Of the three zones surveyed, the north zone appears to be highly productive in prawn seed abundance, dominated by M. dobsoni than the middle and south zones and the seed potential on average being 1088, 304 and 644 Nos./100 m^2 respectively. The middle zone (station 2) appears to be less productive in seed abundance. The influence of strong tidal currents (owing to the nearness to the narrow mouth for the entire vast backwater system), effects of dredging operations, deepening of navigation channel, ferry services and the recent reclamation processes have great impact on the penaeid prawn seed resources of this zone, especially along the shallow belt adjoining Cochin city.

On the other hand, this zone provides pathway for the migrating species along the deeper areas. Due to restriction in fishing operations, particularly in the deeper navigation channel, it is quite likely that the juveniles and preadults escaping from northern and southern regions of the backwater (to avoid unfavourable environmental conditions) may emigrate very safely through the high saline deeper channel to their Home Town, the sea, for maturation and spawning activities.

Based on the length frequency data and the progressive modes observed, an attempt has been made to know whether the present data has got any relevance with the earlier studies on growth determination of these penaeid species by Mohamed and Rao (1971), George (1973), Kunju (1978), and Achuthankutty and Nair (1983); and the results indicated a growth rate of 20 mm per month for *P. indicus* of size between 63 and 93 mm and 13 mm for *M. dobsoni* for the size between 38 and 58 mm while Kunju (1978) has stated a growth rate of 15 and 20 mm respectively for males and females of *P. indicus* while it is stated that growth rate is 10 mm in the case of *M. dobsoni* (Mohamed and Rao 1971). Growth rate could not be traced for *M. monoceros* due to the presence of successive modes of almost same size as observed in North zone and for *M. affinis* due to inadequate data.

The overall weight of penaeid prawns was more at south zone (96.76%) than at north zone (86.31%). It is mainly because of the availability of larger sized *M. dobsoni* at south zone and *M. monoceros* at north zone (Table-11a). The occurrence of larger sized individuals in general and progression of peak modes ahead for these species in south zone may indicate higher growth rate of these species at south zone. It may be due to the relatively less density of *M. dobsoni* per unit area as evidenced from the quantitative data of prawn seeds for north and south zones (Table-9), though the process of mixing up of stocks and migration have great role in the ecosystem.

The environmental factors such as temperature, salinity, dissolved oxygen, food availability and physiological stress have been cited as major factors influencing growth of penaeid prawns (Kunju, 1978). Higher percentage composition of M. dobsoni during the monsoon season indicates that they are more euryhaline in nature than other penaeid species. While seeds of M. dobsoni prefer low salinity, that of P. indicus prefer higher salinity as evidenced by their occurrence in the south zone. Preference of higher or lower salinities by prawn seeds has been deliniated by George and Suseelan (1982). The occurrence of more number of postlarvae and early juveniles of penaeids at high tide observed in the present study is in agreement with the results of Subrahmanyam and Rao (1967), Kuttyamma (1975) and Goswami and George (1978) Postlarval occurrence in high tide indicates recruitment and their abundance recorded in the first few hours of high tide indicates their occurrence in the surf regions of the sea than in the inshore waters. The abundance of bottom dwelling early juveniles in high tide may be attributed to their preference to low temperature caused by the colder saline waters of the sea.

Subrahmanyam (1965) and Subrahmanyam and Rao (1967) have recorded the abundance of prawn seeds in afternoon hours and related it to their immigration during day time. In the present study, their abundance in forenoon collection may be due to preference of low temperature caused by high tide and time (morning hours showed low temperature), coupled with other factors like tidal amplitude, salinity and dissolved oxygen and other chemical components in the water and sediment. At this stage, it is difficult to conclude which factor is actually responsible for the abundance and distribution of prawn seeds during monsoon season. or whether it could be the combination of some factors that determine the distribution, survival and growth of seed and juvenile prawns during their life in the estuary.

Statistical treatment on the diurnal hydrographic data for June-September did not show significant correlation with total prawn seed abundance except salinity which indicated a negative correlation with seed abundance in general. Species-wise analysis indicated a positive correlation in the case of P. indicus and M. monoceros and negative correlation in M. dobsoni with tidal height and negative correlations were obtained for salinity and dissolved oxygen in P. indicus and M. dobsoni at both zones while it was positive at South and negative at north zone for M. monoceros (Table-14).

Since the data is pertaining to a shorter period, the inadequacy of data may lead to unreliability and at times serious errors in statistical analysis. Hence, at this stage, it would be difficult to derive at any definite conclusion. However, the informations provided could be useful in planning further studies in this direction.

SUMMARY

The present investigation aims at a comprehensive knowledge on the size distribution and abundance of cultivable penaeid prawn seeds and juveniles in Cochin Backwater during southwest monsoon season.

The findings and conclusions derived from the present investigation are based on regular collections of weekly catch data on prawn landings, fortnightly data on hydrography, prawn seeds and juveniles of P. indicus, M. dobsoni, M. monoceros and M. affinis from the three stations viz. south zone, middle zone and north zone, and monthly diurnal data on hydrography, postlarvae and seeds of P. indicus, M. dobsoni and M. monoceros from the south and north zones.

The rainfall data obtained during June-September 1987 (160 cm) indicates the failure of southwest monsoon around Cochin region.

The relatively high water temperature, elevated bottom topography, high dissolved oxygen content and the relatively less tidal amplitude, low tidal influence and salinity are the characteristic features of the north zone when compared to middle and south zones.

M. dobsoni is found to be the dominant species in the entire ecosystem during this season. Following that, M. monoceros stands second in dominance at north zone and P. indicus at south zone. Among juveniles, M. affinis is the least among the four species studied.

Monthly percentage abundance of postlarvae and seeds of M. dobsoni reveals continuous recruitment during the season.

The absence of seeds of M. affinis during June-September and poor representation of juveniles indicate that their spawning season does not fall during June-September.

The absence of larger sized juveniles in the shallow areas of less than one metre depth and their occurrence in deeper areas as evidenced from the prawn landings of this ecosystem confirms their movement to the deeper areas of the backwater.

The low percentage of larger size groups of these species recorded from the fishery samples indicates emigration.

Representation of all size groups as observed in M. dobsoni indicates seggregation of the species at north and south zones.

The uneven distribution of size groups in P. indicus and M. affinis at both zones and of M. monoceros at south zone especially during August-September is due to fishery exploitation.

The sudden occurrence or replacement of missing intermiediate size groups in a particular fortnight or month, as observed in P. indicus and M. affinis, may be related to the movement of the species from other areas; The progressive increase in prawn catch from June to September is a clear indication of their movement to these zones.

The present study confirms the dominance of females in P. indicus, M. dobsoni and M. monoceros and males of M. affinis in the ecosystem during this season.

The size distribution of males and females of these four species (Fig.9) confirms that the males and females are distributed in almost same size groups in the ecosystem; This rules out the process of emigration of one sex earlier.

It is concluded that the variations in the sex ratio of penaeid prawns from zone to zone is related to recruitment and mixing of different stocks due to environmental stress in the ecosystem.

The average seed resource potential is estimated as 1088, 644 and 304 Nos/100 m^2 for north, south and middle zones in the order of abundance; and on average it is 680 seeds/100 m^2 for the ecosystem during monsoon season.

Species-wise seed resource potential has been estimated as 616, 48 and 16 Nos/100 m^2 for M. dobsoni, P. indicus and M. monoceros respectively in the order of abundance during this season. P. monodon and P. semisulcatus are rare in the ecosystem contributing less than 0.5% in aggregate.

The estimated penaeid prawn juvenile catch of 5334 and 12004 Kgs from north and south zones indicate the fishery potential of the respective zones and the species-wise composition on average being M. dobsoni (70.8:43.0), M. monoceros (15.9:27.9), P. indicus (10.3:25.0) and M. affinis (3.0:4.1) in percentage by number and weight respectively in the order of abundance.

The relation between number and weight of penaeids indicates that weight increased in % for P. indicus, M. monoceros and M. affinis and decreased in M. dobsoni.

The ratio between number and weight may be used as an index to determine the size of juvenile population in space and time. The larger size of M. monoceros and M. dobsoni are responsible for the higher percentage by weight at north and south zones respectively.

Based on the progression of peak modes, growth rate of *P. indicus* has been traced as 20 mm/month between 63 and 93 mm and that of *M. dobsoni* as 13 mm/month for the size between 38 and 58 mm. Progression of modes are not clear for *M. monoceros* and *M. affinis*.

Since the hydrographic and biological data are pertaining to a shorter period, statistical conclusions may lead to unreliability. Although tide, time, temperature, salinity and dissolved oxygen show some relationship with prawn seed abundance, their overlapping in the ecosystem has made it difficult to conclude, at this stage, which factor or factors are responsible for their abundance and distribution during monsoon season.

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